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MEMOIRS

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VOL. XXVI.

146070
20/5/18

CAMBRIDGE, MASS., U. S. A.
1902–1911.

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The Cosmos Press:

Edward W. Wheeler, Cambridge, Mass., U. S. A.

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Memoirs of the Museum of Comparative Zoology
AT HARVARD COLLEGE.
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REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U.S.N., COMMANDING.

I.

PRELIMINARY REPORT

AND

LIST OF STATIONS.

By ALEXANDER AGASSIZ.

WITH REMARKS ON THE DEEP-SEA DEPOSITS

By SIR JOHN MURRAY.

WITH TWENTY-ONE CHARTS.

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CAMBRIDGE, U.S.A.:
Printed for the Museum.
January, 1902.

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Reports on the Scientific Results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., commanding.

I.

PRELIMINARY REPORT.

TOGETHER WITH A LIST OF THE STATIONS OCCUPIED BY THE "ALBATROSS."

By ALEXANDER AGASSIZ.

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I arrived at San Francisco on August 20th, and after consulting with Commander Moser we decided to leave on Wednesday, the 23d.[1] Everything shipped from the East had arrived with the exception of the tow-nets sent me by Dr. Krämer, and the deep-sea nets kindly ordered for me by Professor Chun of Leipzig. Captain Moser and I decided not to make any soundings nor do any deep-sea work until we had passed beyond the lines of soundings already run by the "Albatross" and "Thetis" between California and the Hawaiian Islands.

In latitude 31° 10′ N., and longitude 125° W., we made our first sounding in 1955 fathoms, about 320 miles from Point Conception, the nearest land. We occupied twenty-six stations until we reached the northern edge of the plateau from which rise the Marquesas Islands, having run from Station 1, a distance of 3800 miles, in a straight line.

At Station 2 the depth had increased to 2368 fathoms, the nearest land, Guadelupe Island, being about 450 miles, and Point Conception nearly 500 miles, distant. The depth gradually increased to 2628, 2740, 2810, 2881, 3003, and 3088 fathoms, the last in lat. 16° 38′ N., long. 136° 14′ W.,

[1] Explorations of the "Albatross" in the Pacific Ocean. [Extract from a letter to the Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, Washington, D. C., dated Papeete Harbor, Tahiti Island, 30 September, 1899, on the trip of the "Albatross" from San Francisco to Papeete, by Alexander Agassiz.] Am. Jour. Sci., Fourth Series, Vol. IX., No. 49, January, 1900.

the deepest sounding we obtained thus far in the unexplored part of the Pacific through which we were passing. From that point the depths varied from 2883 to 2690 and 2776, diminishing to 2583, and gradually passing to 2440, 2463, and 2475 fathoms, until off the Marquesas, in lat. 7° 58′ S., long. 139° 08′ W., the depth became 2287 fathoms. It then passed to 1939, 1802, and 1040 fathoms in lat. 8° 41′ S., long. 139° 46′ W., Nukuhiva Island being about twenty miles distant. Between Nukuhiva and Hounanu Point, Ua-Huka Island, we obtained 830 fathoms, and five miles south of Nukuhiva 687 fathoms. When leaving Nukuhiva for the Paumotus we sounded in 1284 fathoms about nine miles south of that island. These soundings seem to show that this part of the Marquesas rises from a plateau having a depth of 2000 fathoms and about fifty miles in width, as at Station 29 we sounded in 1932 fathoms.

Between the Marquesas and the northwestern extremity of the Paumotus we occupied nine stations, the greatest depth on that line being 2700 fathoms at Station 31, in lat. 12° 20′ S., and long. 144° 15′ W. The depths varied between 2451 and 2527 fathoms, and diminished to 1208 fathoms off the west end of Ahii, and then to 706 fathoms when about sixteen miles N.E. off Avatoru Pass in Rangiroa atoll.

We developed to a certain extent the width of the Paumotu Group plateau by a line of soundings in continuation of the direction of Avatoru Pass, extending a little less than nine miles seaward, where we obtained a depth of 819 fathoms. Subsequently we ran a similar line normal to the south shore of the lagoon of Rangiroa, a distance of nearly twelve miles, into 897 fathoms.

Between Rangiroa and Tikehau, the next atoll to the westward, we obtained a depth of 1486 fathoms.

Between Tikehau and Matahiva six soundings were made, with a depth of 188 fathoms half a mile from shore, and a greatest depth of 850 fathoms six and one half miles from Tikehau. The slope approaching Matahiva is steeper than the Tikehau slope.

From Matahiva to Makatea (Aurora) Island, we made six soundings: from 624 fathoms about two and one half miles off shore to 581 fathoms about one and one eighth miles off the west side of the latter island, the

depths passing to 860, 1257, 1762, and the greatest depth being 2267 fathoms, then 2247, and rising more rapidly near Makatea to 581 fathoms.

Between Makatea and Tahiti we made eight soundings, beginning with 1363 fathoms, two miles off the southern end of Makatea, passing to 2238, 2363 (the greatest depth on that line), to 2224, 1930, 1585, 775, and finally 867 fathoms off Point Venus.

These make in all seventy-two soundings from our first station to Point Venus.

The deep basin developed by our soundings between lat. 24° 30′ N., and lat. 6° 25′ S., varying in depth from nearly 3100 fathoms to a little less than 2500 fathoms, is probably the western extension of a deep basin indicated by two soundings on the charts,[1] to the eastward of our line, in longitudes 125° and 120° W., and latitudes 9° and 11° N., one of over 3100 fathoms, the other of more than 2550 fathoms, showing this part of the Pacific to be of considerable depth and to form a uniformly deep basin of great extent, continuing westward probably, judging from the soundings, for a long distance.

I would propose, in accordance with the practice adopted for naming such well-defined basins of the ocean, that this large depression of the Central Pacific, extending for nearly thirty degrees of latitude, be named Moser Basin.

In naming the "Moser" Basin I am following the practice adopted by the "Challenger" and Coast Survey, of naming after naval officers or the ships they commanded prominent hydrographic features. Dr. Neumayer in 1882, in the Atlas of the Atlantic Ocean issued by the German Marine Observatory, was the first to object to this system of nomenclature, on the ground of the confusion likely to arise from the adoption of personal names when applied to ridges, basins, deeps, and plateaus in the different oceanic realms. He proposed a strictly geographical nomenclature, which ignored the personal names given in the earlier bathymetrical charts; and the same principle was carried out in the Atlas of the Indian and Pacific Oceans subsequently published by the German Marine Observatory. Finally, Professor Supan, in his article on "Die Bodenform des Welt-

[1] H. O. Chart, No. 527.

meeres."[1] has followed the same principle, and has in no way recognized the names which appear on the "Challenger" bathymetrical chart or the earlier charts of Petermann, issued in 1877, or in the charts issued by the U. S. Coast and Geodetic Survey. In order to prevent a possible future confusion, the Germans have deliberately created it; for Professor Supan objects on "national grounds" to Sir John Murray's proceeding of "tagging the oceans as if they were Anglo-Saxon dominions," and insists that such a proceeding "can never receive general recognition." Professor Supan considers the Anglo-Saxon method "as impracticable because in the future it may burden the memory of the school children of the next generation." If we are to have a remodelling of the oceanic bathymetrical nomenclature, it seems as if we were attempting it with very insufficient data, at least as far as the Pacific is concerned. Professor Supan himself has called attention to the fact that the bottom of the Pacific Ocean is far less uniform in depth than would appear from the earlier charts; and certainly the great blank spaces left between the lines of soundings make it sufficiently clear how tentative all our attempts to chart the depths of the Pacific must be for some time to come. Of course, I do not in any way wish to object to a more strict limitation of the hydrographic terms proposed by Dr. Supan, many of which have naturally in the earlier days of deep-sea explorations been applied somewhat vaguely. In the meantime basins, deeps, and ridges, such as are sketched and named on the earlier charts, will gradually disappear as subsequent explorations show them to be connected; others again will be subdivided as our knowledge of the depths of the oceans becomes more accurate.

No geographer has as yet attempted for land names to make such a sweeping reform as that proposed by the Germans. It is true that the great oceanic realms are common property, and have not as yet, like the islands scattered in the Pacific, become included in regions of English, French, German, or American influence. But it will appear to an Anglo-Saxon as natural, from a national standpoint, to adhere to his nomenclature as it seems important to the German, for the same reason, to adopt a different system. To a naturalist accustomed to have such questions settled for

[1] Petermann's Mitteil., Bd. 45, 1899, p. 177.

"ALBATROSS" TROPICAL PACIFIC EXPEDITION

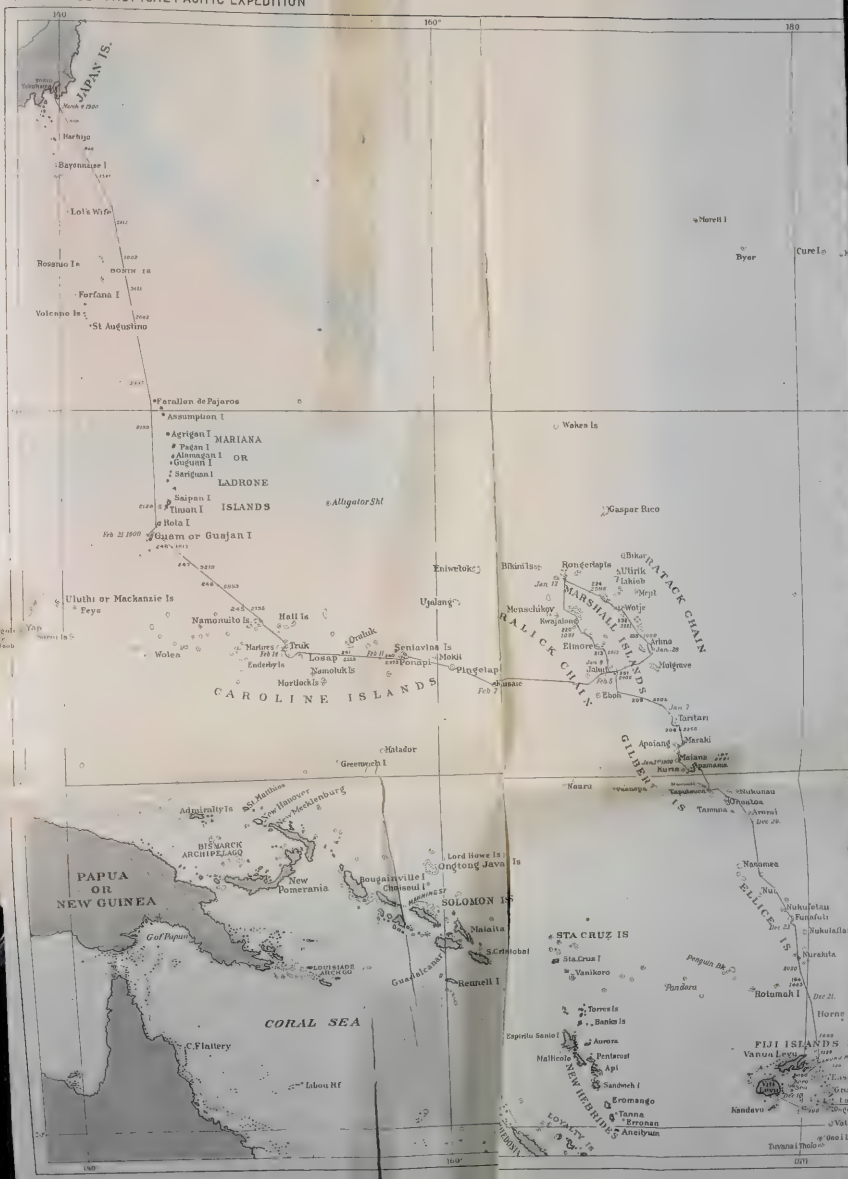
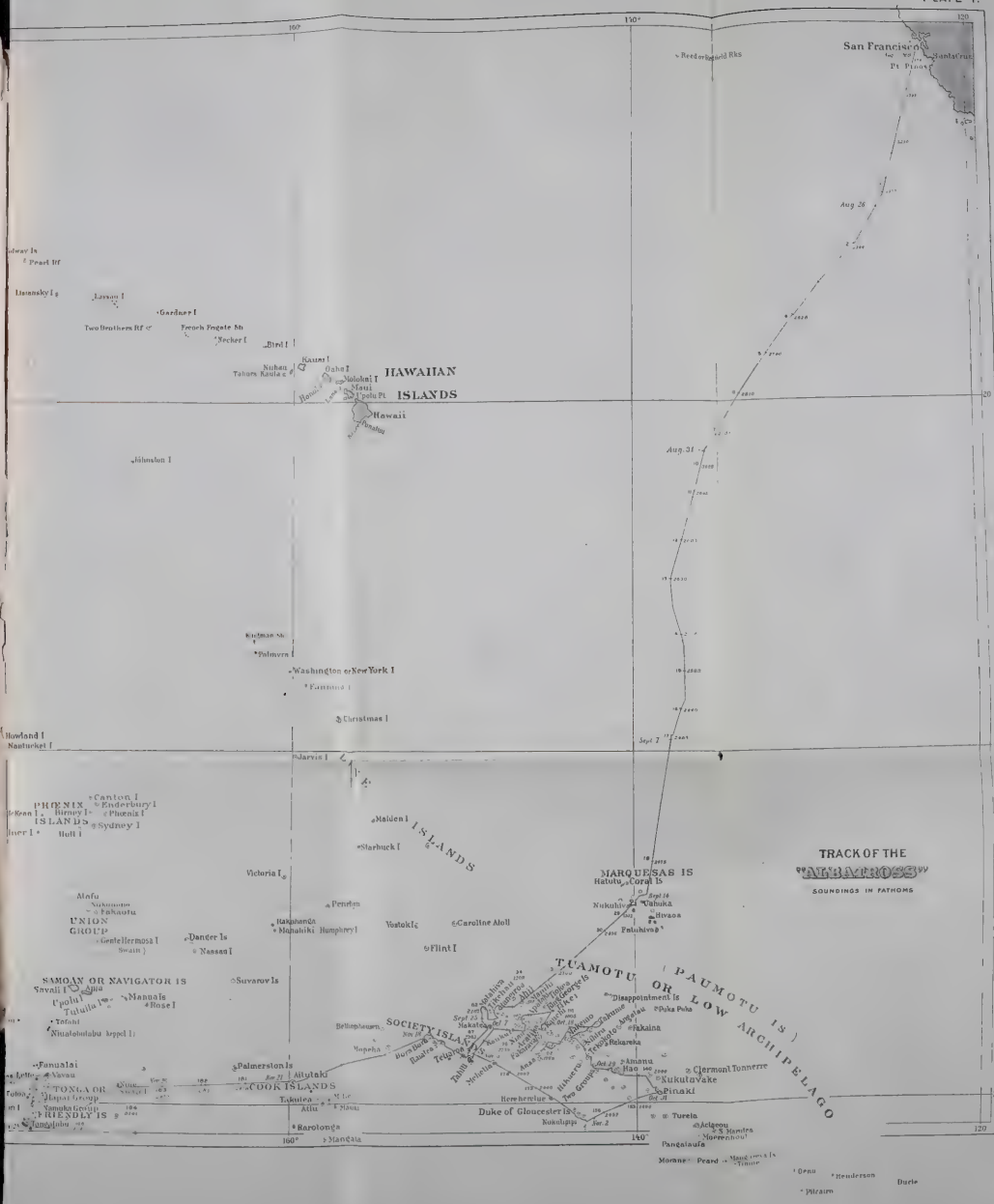

JAPAN IS.
Harbigo
Bayonnaise I
Lot's Wife
Rosario Is
NORTH I.
Forfana I
Volcano Is
St Augustino
Farallon de Pajaros
Assumption I
Agrigan I
Pagan I
Alamagan I
Guguan I
Sarigan I
MARIANA OR LADRONE ISLANDS
Saipan I
Tinian I
Rota I
Guam or Guajan I
Alligator Sht
Ulithi or Mackanzie Is
Feys
Namonuito Is
Hall Is
Truk
Oraluk
Losap
Senyavins Is
Mokil
Ponapi
Pingelap
Mortlocks
Namoluk Is
Wolea
CAROLINE ISLANDS
Eniwetok
Ujelang
Bikini Is
Rongerik Is
Ailuk
Utirik
Likieb
Mejit
Wotje
Menschikoff
Korallova
Erikub
Jaluit
Ebon
Arno
Majuro
Mulgrave
RATACK CHAIN
RALICK CHAIN
MARSHALL ISLANDS
Gaspar Rico
Wakes Is
Halador
Greenwich I
Tarawa
Apaiang
Maraki
Makin
Kuria
Tamana
GILBERT IS
Nauru
Ocean I
Tabiteuea
Arorai
Tamana
Admiralty Is
St Matthias
New Hanover
Mecklenburg
BISMARCK ARCHIPELAGO
PAPUA OR NEW GUINEA
New Pomerania
Bougainville I
Choiseul I
Lord Howe Is
Ontong Java Is
SOLOMON IS
Malaita
St Cristobal
Guadalcanal
Rennell I
Gulf of Papua
LOUISIADE ARCHIPELAGO
CORAL SEA
Flattery
Cape Labou Hd
STA CRUZ IS
Sta Cruz I
Vanikoro
Penguin Bk
Pandora
Torres Is
Banks Is
Espiritu Santo
Aurora
Malliccolo
Pentecost
Api
Sandwich I
Bromango
Tanna
Erronan
Aneityum
NEW HEBRIDES
LOYALTY IS
NUMEA
Nanomea
Nui
Nukufetau
Funafuti
Nukulaelae
Nukulailai
Nurakita
Rotumah I
Horne Is
FIJI ISLANDS
Vanua Levu
Kandavu
Eastern Group
Lau
Vatoa
Tuvana i Tholo
Ureo I
Niua
Gaua
Pentecost
Api
Sandwich I
Bromango
Tanna
Erronan
Aneityum
Kandavu

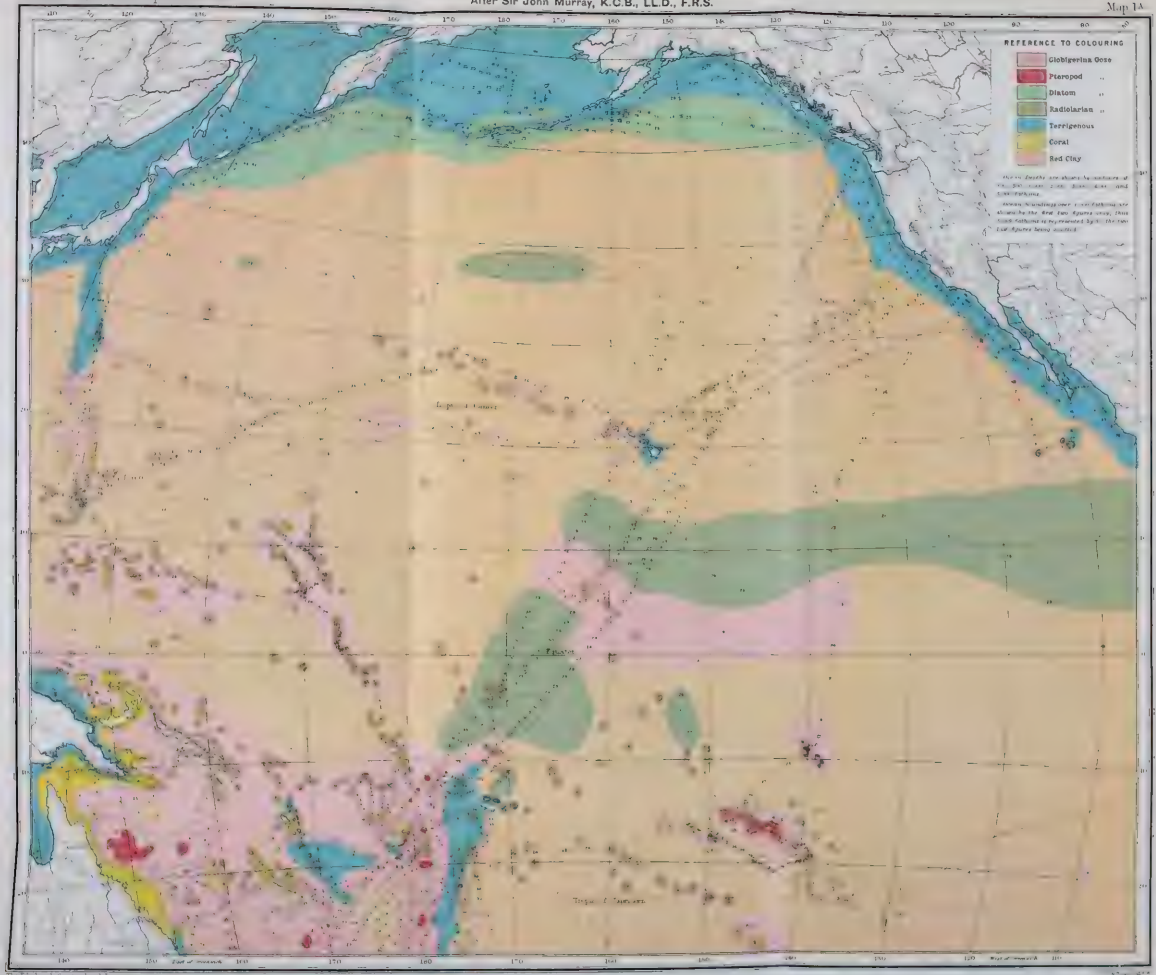
PLATE 1.


TRACK OF THE ALBATROSS
SOUNDINGS IN FATHOMS
HAWAIIAN ISLANDS
LINE ISLANDS
PHOENIX ISLANDS
MARQUESAS IS
TUAMOTU (PAUMOTU IS.) OR LOW ARCHIPELAGO
SOCIETY ISLANDS
SAMOAN OR NAVIGATOR IS
UNION GROUP
COOK ISLANDS
TONGA OR FRIENDLY IS
San Francisco
Santa Cruz
Pt Pinos
Reed or Bedd Rks
Aug 26
Aug 31
Sept 7
Pearl Hr
Lisianski I
Laysan I
Gardner I
Two Brothers Rf
French Frigate Sh
Necker I
Bird I
Kauai
Nihau
Oahu
Molokai I
Maui
Oahu Pt
Hawaii
Kaula
Johnston I
Kingman Sr
Palmyra I
Washington or New York I
Fanning I
Christmas I
Howland I
Nantucket I
Jarvis I
Canton I
Enderbury I
Phoenix I
Sydney I
Hull I
Gardner I
Malden I
Starbuck I
Victoria I
Penrhyn
Nukuhiva
Uahuka
Hivaoa
Fatuhiva
Makatea
Takume
Puka Puka
Fakaina
Rekareka
Amanu
Hao
Clermont Tonnerre
Kukutavake
Pinaki
Reao
Tureia
Acteon
Morrell
Pandora Ra
Moruroa
Peard
Oeno
Henderson
Ducie
Pitcairn
Aratika
Fakahina
Carolina Atoll
Vostok I
Flint I
Danger Is
Nassau I
Suvarov Is
Manuae Is
Rose I
Tafahi
Niuafoobu
Bellinghausen
Mopeha
Fanualai
Vavau
Palmerston Is
Aitutaki
Takutea
Atiu
Mauke
Rarotonga
Mangaia
Duke of Gloucester Is
Nukuhiva
Ker 2
Two Groups
Ker 3
Ker 4
Ker 5
Ker 6
Ker 7
Ker 8
Ker 9
Ker 10
Ker 11
Ker 12
Ker 13
Ker 14
Ker 15
Ker 16
Ker 17
Ker 18
Ker 19
Ker 20
Ker 21
Ker 22
Ker

MARINE DEPOSITS

After Sir John Murray, K.C.B., LL.D., F.R.S.

Map 1A.



The Edinburgh Geographical Institute

Track of "Albatross" shown thus

Albatross Tropical Pacific Expedition, 1899-1900

OCEAN DEPTHS

Compiled from the latest sources 1901.

Map 1[illegible]

REFERENCE TO COLOURING

SEA LEVEL
100 Fathoms
500
1000
2000
3000
4000
6000

Tho' in Soundings over 1,000 fathoms are shown by the first two figures only, thus 5-32 fathoms is represented by 52, the two last figures being omitted

Tropic of Cancer

Equator

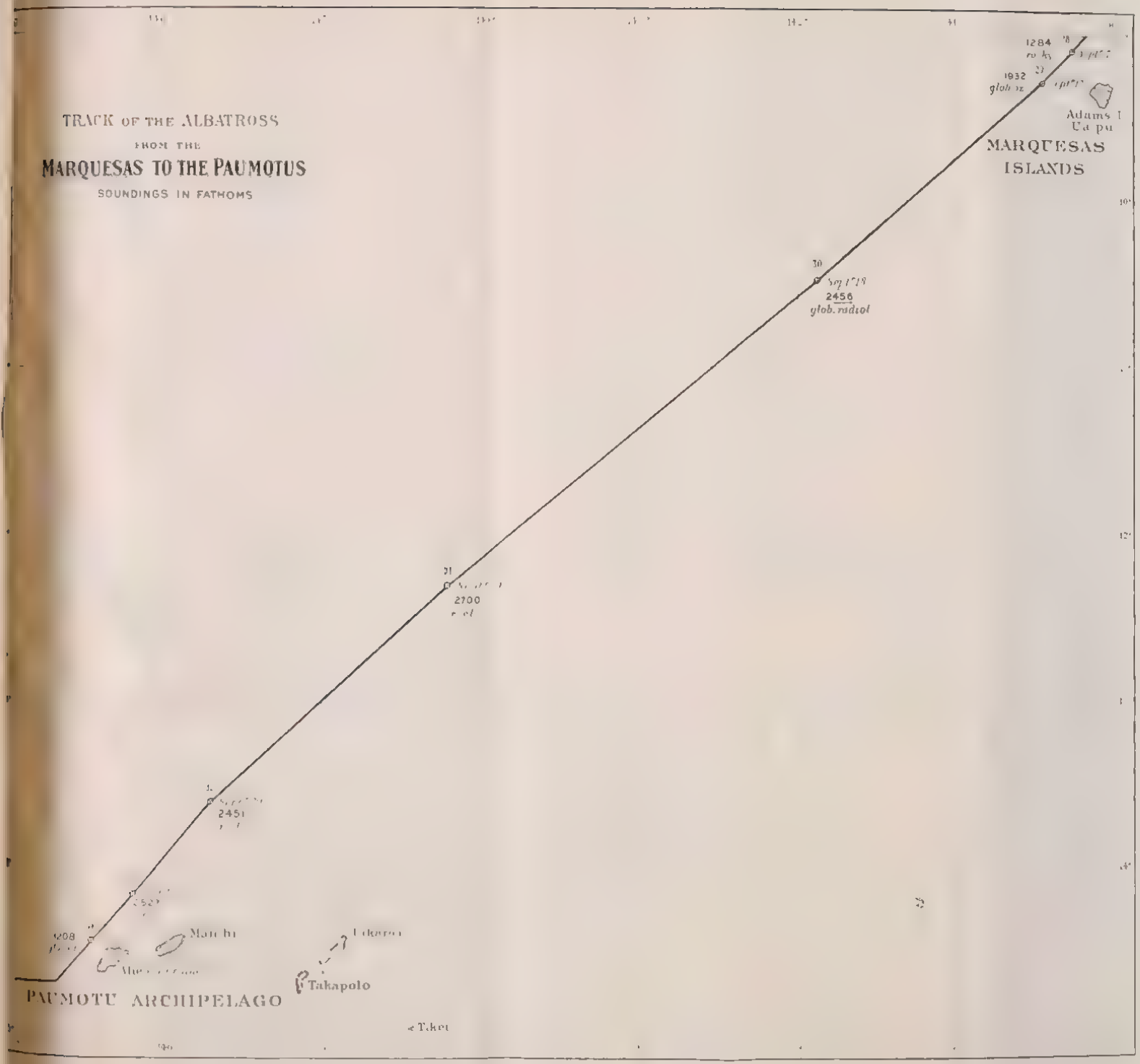
Tropic of Capricorn

Track of Albatross shown thus

J G Bartholomew

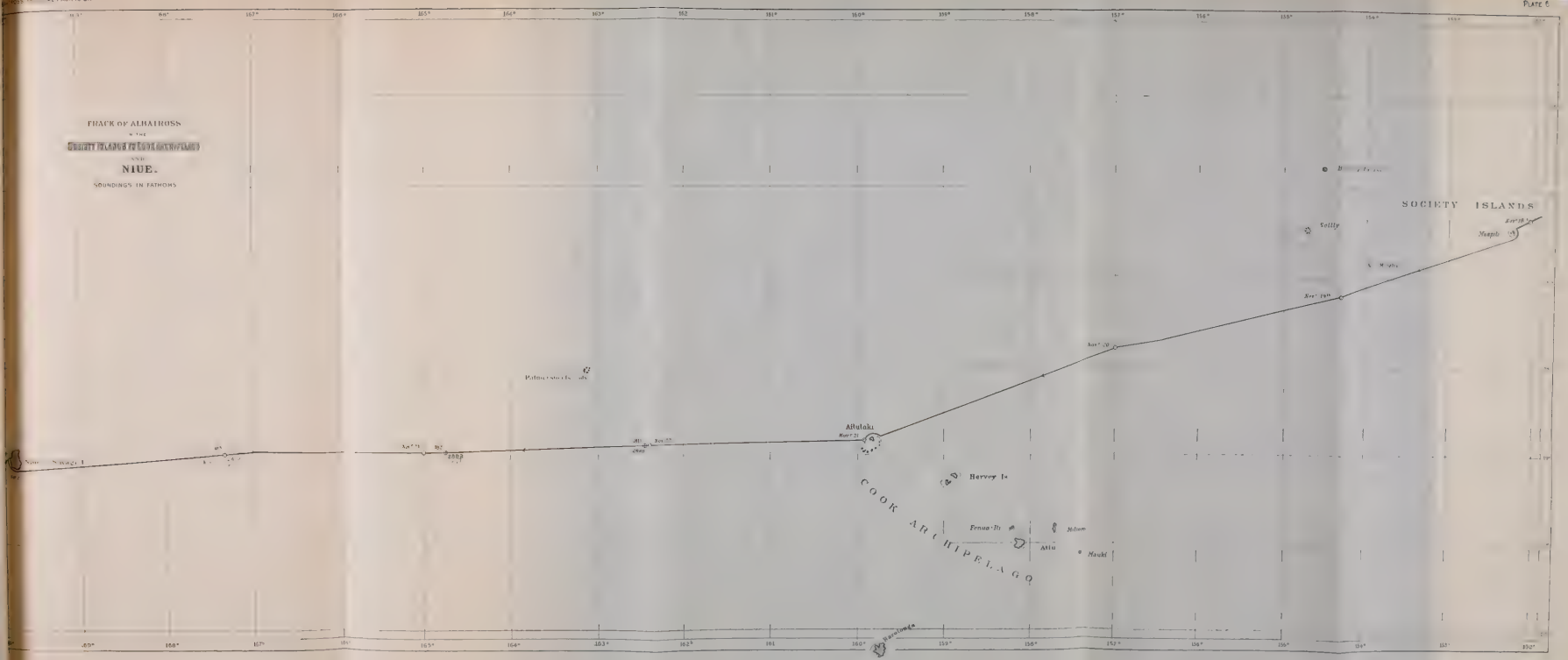
TRACK OF THE ALBATROSS
FROM
SAN FRANCISCO TO MARQUESAS
SOUNDINGS IN FATHOMS
San Francisco
CALIFORNIA
Edge of Marquesas Plateau
MOANA HAI

TRACK OF THE ALBATROSS
THROUGH THE
MARQUESAS ISLANDS
SOUNDINGS IN FATHOMS
Hatutaa Channel
Eiao, Masse I.
2287
glob ooz
2183
glob ooz vol., sct
1939
glob ooz vole part
1822
gl globs mod vole part
glob ooz vole part
U.S.F. Hergest R.
NUKUHIVA or
MARCHAND I
Hakaui B
Hatiheu B
C Martin
Anna Maria Bay
Chukaheu Pt
810
glob vol mud
1173
Ekaumanu B
glob ooz ptr
Washington I.
Ua Huka
1284
glob ooz vole part
Motane
Hakahau B
Hakahou B
Adams I
Ua pu
Hatuna B
Hooumi B
HIVA OA or DOMINICA I
C Kuakua
Atuona
Taaoa
Hanamoenoa B
Traitors B
Bordelais Str
St Christina
Tahuata
San Pedro I
Tromouri
Magdalena I.
Fatu huva
Hanamoe
2456
glob mud vole part


TRACK OF THE ALBATROSS
FROM THE
MARQUESAS TO THE PAUMOTUS
SOUNDINGS IN FATHOMS
1284
1932
Adams I
Ua pu
MARQUESAS
ISLANDS
30
2456
31
2700
2451
Takapolo
PAUMOTU ARCHIPELAGO

LEEWARD GROUP
SOCIETY ISLANDS
PAUMOTU ARCHIPELAGO
TAHITI
Moorea
Tahaa
Borabora
Huaheine
Raiatea
Maupiti
Mopelia
Motu Iti
Mehetia
Tubuai
Rimatara
Rurutu
Manihi
Takaroa
Takapoto
Tikei
Apataki
Arutua
Kaukura
Toau
Kauehi
Raraka
Katiu
Tuanake
Tahanea
Tepoto
Motulunga
Fakarava
Rangiroa
Hikueru
Marokau
Reitoru
Haraiki
Tekokota
Ravahere
Takume
Raroia
Tamoa
Nakeno
Maralea
Rekareka
Tauere
Fakaina
Angatau
Puka-Puka
Amanu
Hao
Nengonengo
Manuhang
Paraoa
Ahunui
Vairaatea
Vahitahi
Aki Aki
Nukutipipi
Pinaki (Whitsunday)
Anu-Anuraro (Mangareva)
Hereheretue (Duff Group)
Tatakoto
Puka-puka (Danger Is.)
Reao (Clermont Tonnerre)
Napuka
TRACK OF ALBATROSS
IN THE
PAUMOTU ARCHIPELAGO
AND
SOCIETY ISLANDS
SOUNDINGS IN FATHOMS.

TRACK OF ALBATROSS
IN THE
SOCIETY ISLANDS TO COOK ARCHIPELAGO
AND
NIUE.
SOUNDINGS IN FATHOMS


SOCIETY ISLANDS
Tahiti
Moorea
Huahine
Raiatea
Tahaa
Bora Bora
Maupiti
Nov 19th
Nov 20
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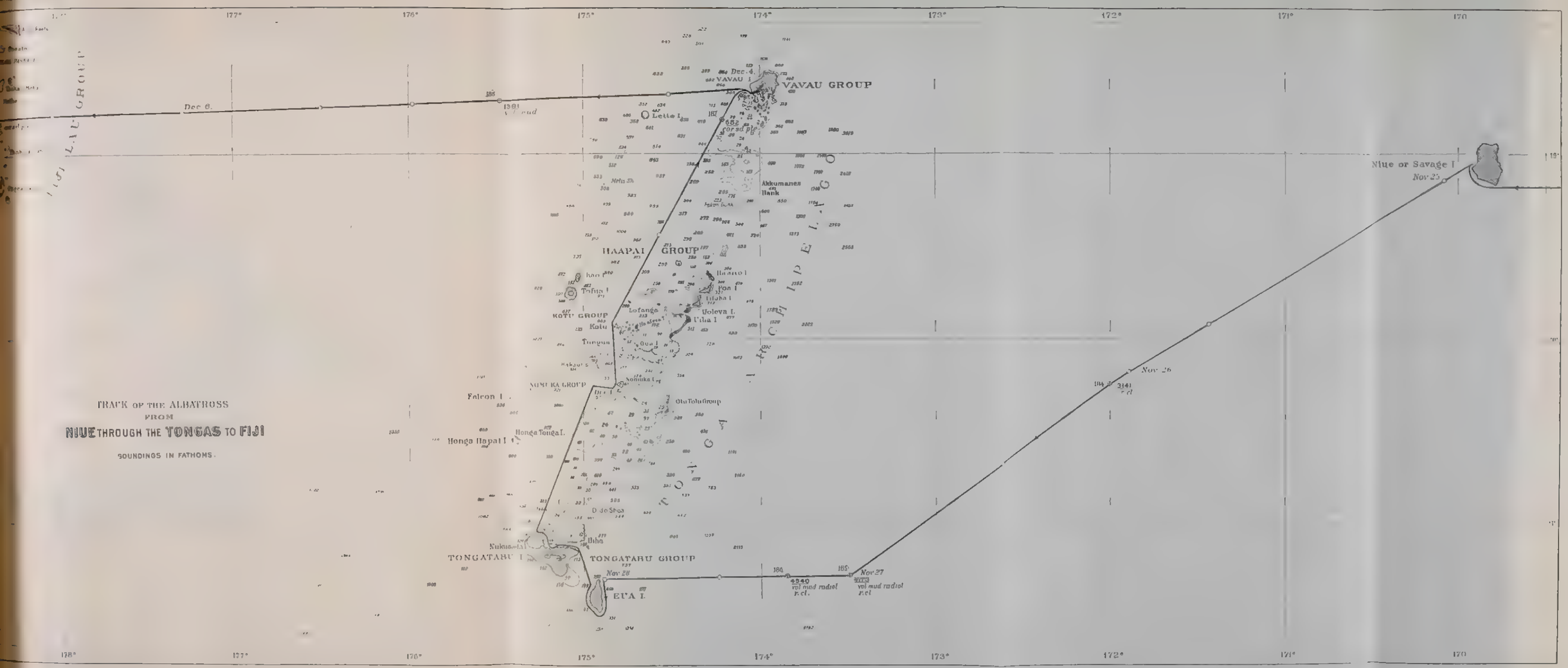
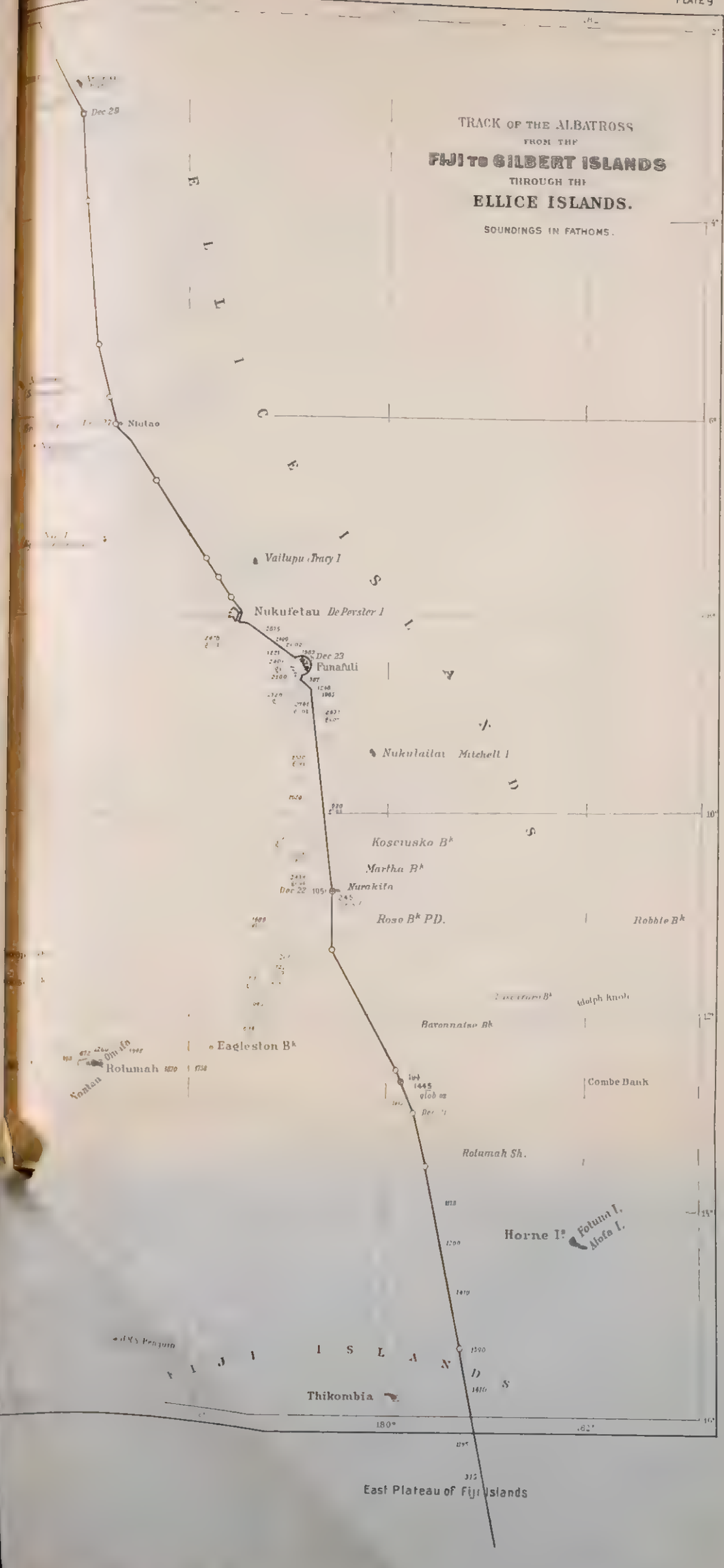
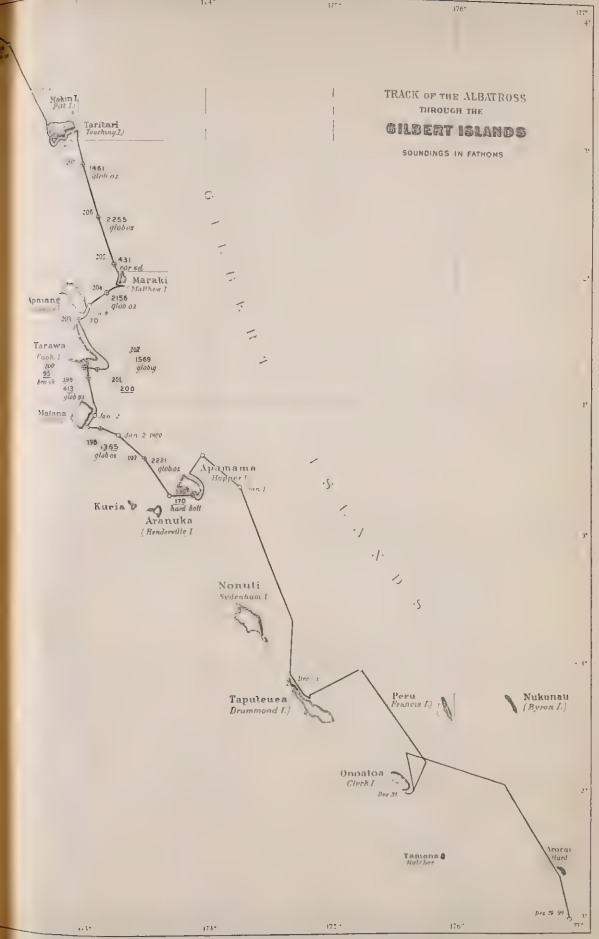

177°
176°
175°
174°
173°
172°
171°
170
FIJI ISLAU GROUP
Dec 6.
1381 fathoms mud
Dec 4.
VAVAU I
VAVAU GROUP
O Lette I
682 fathoms soft ooze
Akkumanes Bank
Niue or Savage I
Nov 25
HAAPAI GROUP
Kao
Tofua I
Ha'apai I
Fon I
Lifuka I
KOTU GROUP
Kalu
Lofanga
Uoleva I.
Uiha I
Tongan
Oua I
Nomuka I
NOMUKA GROUP
Falcon I
Ota Tolu Group
Honga Tonga I.
Honga Hapai I
D de Shoa
Kulua I.
Uiha
TONGATABU I
TONGATABU GROUP
Nov 28
EUA I.
186
185
Nov 27
4540 fathoms vol mud radiol rel.
3073 fathoms vol mud radiol rel
Nov 26
184
3141 fathoms rel
TONGA ISLANDS
TRACK OF THE ALBATROSS
FROM
NIUE THROUGH THE TONGAS TO FIJI
SOUNDINGS IN FATHOMS.
178°
177°
176°
175°
174°
173°
172°
171°
170

TRACK OF THE ALBATROSS
THROUGH THE
FIJI ISLANDS
VANUA LEVU
VITI LEVU
KORO
SEA
Thikombia
Vatoa
Ngele Levu
Cape Lindo
The Great Sea Reef
Adolphus Rf
Nuku Mbasanga
Buas Rf
Namba I
Motua Levu
Nerada Rf
Duff Reef
Dibbles Rf
Kimbombo
Saitamb
Malima Is
Yathata
Knathea
EXPLORING ISLES
Mango I
Malevuvu Reef
Katafanga
Thakau Tambu
Tuvutha
Thithia
Thakau Lasmarawa
Reid Reef
Natau
Lakemba
Vanua Vatu
Oneata
Thakau Lesakau
Moala
Tova
Tavanas Ibi
Wangava
Bambara
Yangasa Chasm
Fulanga
Ongea Levu
Matuku
Vatoa or Turtle I
Viwa I
NAVITI
NASAWA
Asawa Harbour
Chaybdis Reef
Kamena Barr Reef
Makongai
Horse-Shoe Reef
OVALAU
Nhatikoko
Nairai
Vatu Vara
Vatu Lele
North Astrolabe Rf
Great Astrolabe Reef
KADAVU
MAMANUTHA ISLANDS
SOMO SOMO STRAIT
NAVULA PASSAGE
BUKATATAU PASSAGE
LAKE MBAU PASSAGE
EASTERN GROUP
FIJI ISLANDS
Commandment Group
to Southward.
Vatoa or Turtle I
Oneatlaw
Dec 19
Dec 20
SOUNDINGS IN FATHOMS

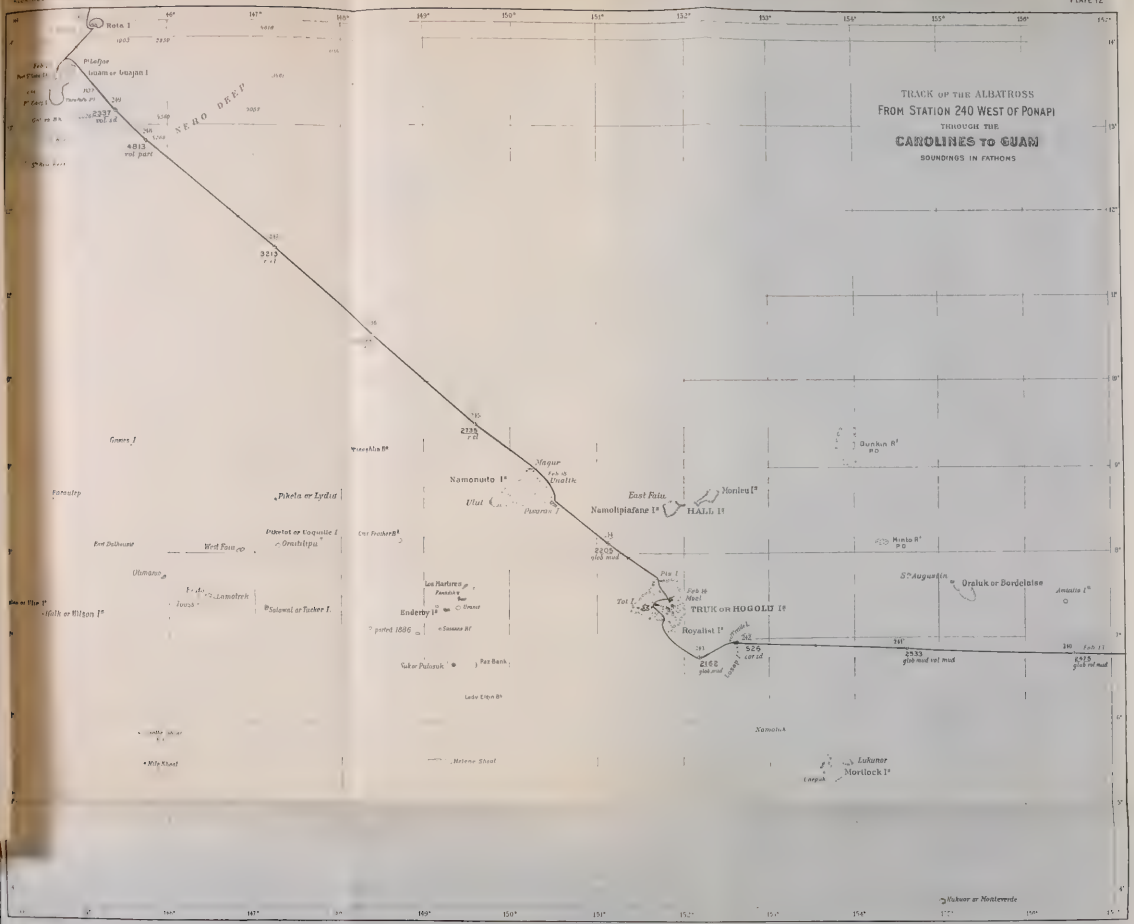

TRACK OF THE ALBATROSS
FROM THE
FIJI TO GILBERT ISLANDS
THROUGH THE
ELLICE ISLANDS.
SOUNDINGS IN FATHOMS.
Dec 29
Niutao
Vaitupu (Tracy I
Nukufetau DePeyster I
Dec 23
Funafuti
Nukulailai Mitchell I
Kosciusko Bk
Martha Bk
Dec 22
Nurakita
Rose Bk PD.
Robbie Bk
Eagleston Bk
Rotumah
Vanua
Baronnatau Bk
Combe Bank
Rotumah Sh.
Horne Is
Futuna I.
Alofa I.
Penguin
FIJI ISLANDS
Thikombia
180°
East Plateau of Fiji Islands


TRACK OF THE ALBATROSS
THROUGH THE
GILBERT ISLANDS
SOUNDINGS IN FATHOMS
Makin I.
Apaiang I.
Taritari
Touching I.
1461
globig oz
2255
globig oz
431
coar sd
Maraki
Matthew I
2156
glob oz
Ipiaing
Tarawa
Cook I
1569
globig
55
brn cls
413
glob gy
200
Malinna
Brn 2 1900
365
glob os
2231
globig
Apamama
Hopper I
Kuria
Aranuka
Henderville I
Nonuti
Sydenham I
Tapuleuea
Drummond I.
Peru
Francis I.
Nukunau
Byron I.
Onoatoa
Clerk I
Dec 31
Tamana
Halliburton
Arorai
Hurd
Dec 31 99

TRACK OF THE ALBATROSS
THROUGH THE
MARSHALL ISLANDS
AND TO
PONAPI, CAROLINES.

SOUNDINGS IN FATHOMS

Taongi
Smyth or Gaspar Rico Atoll
M A R S H A L L I S L A N D S
Bikar or Dawson Atoll
Enewetok or Brown Atoll
Bikini or Eschholtz Atoll
Rongelab Atoll
Rongerik Atoll
Utirik or Kutusov I.
Taka or Suvarov
Ailinginae Atoll
Wotho or Schanz Atoll
Ujelang, Arecifos or Providence Atoll
Ailuk or Tindal & Watts Atoll
Mejit Atoll
Jemo I.
Likieb Atoll
Wolje or Romanzov Atoll
Ujae or Katharine Atoll
Kwajalong or Menschikov Atoll
Erikub
Lae Atoll
Maloelab Kaven or Calvert Atoll
Aurh or Ibbetson Atoll
Lib I.
Namu or Musquillo Atoll
Elmore or Odia Atoll
Majuro or Arrowsmith Atoll
Arhno Atoll
C A R O L I N E I S L A N D S
Ponapi or Puynepet I., Seniavina I.
Mokil or Duperrey I.
Pingelap or Macaskill I.
Kusaie or Ualan I.
Chabrol
Namorik or Baring Atoll
Jaluit or Bonham Atoll
Mille or Mulgrave Atoll
Knox I.
Kitt or Hunter I.
Ebon or Boston Atoll


TRACK OF THE ALBATROSS
FROM STATION 240 WEST OF PONAPI
THROUGH THE
CAROLINES TO GUAM
SOUNDINGS IN FATHOMS
NERO DEEP
Rota I.
Guam or Guajan I.
Namonuito I.
Ulul
East Fais.
Namolipiafare I.
HALL Is.
Moriieu I.
TRUK OR HOGOLU Is.
Royalist I.
Dublon
Uman
Tol
Param
Fefan
Ualan or Strong I.
Lamotrek
Satawal or Tucker I.
Enderby I.
Oroluk or Bordelaise
St. Augustin
Amanas I.
Dunkin R.
Minto R.
Gaferut
Pikelot or Lydia
Pulusuk
Namonuk
Lukunor
Mortlock Is.
Nukuor or Monteverde
Walk or Wilson I.
Mile Shoal
Halcyon Shoal
Ledo Elcan Bk.
Pat Bank
Les Hartures
Fontaine
Sesame Bk.
Grant
Gaspar
Swain
Feb 10
Mael
Feb 11
Pin I.
Tol I.
Dublon I.
Eten I.
Uman I.
Fefan I.
Param I.
Ulul I.
Namonuito I.
Pisarai I.
Magur
Dualik
Feb 10
Dualik
Feb 11
Gaferut
Fais
Namolipiafare I.
Moriieu I.
HALL

TRACK OF THE ALBATROSS FROM GUAM TO YOKOHAMA.

SOUNDINGS IN FATHOMS

Cho On Pt

Inabove said

Yokohama

Overfalls

Mark I

Volcano

Smith I

Parallon

Lots Wife

BONIN ISLES

Parry I

Kater Bk

Beechey Group

Peel I

Coffin I

Submarine Volcano

St Alessandro

Volcano

Sulphur I

Islands

Grampus I

Reef

Rock

Euphrosyne or Salt Rock

Valetta Bk

Parallon de Pajaros

Urracan I

Assumption

MARIANA OR

Agrigan I

Pagan I

Alamagan I.

Guguai I

LADRONE

Zealandia Bk

Sariguan I.

Anatacan I.

Parallon de Medinilla

Reefs

Shoal

Saipan Id

Tinian

Aguijan I

ISLANDS

Rota I

Guajan I

Tuson I

Menses Rf

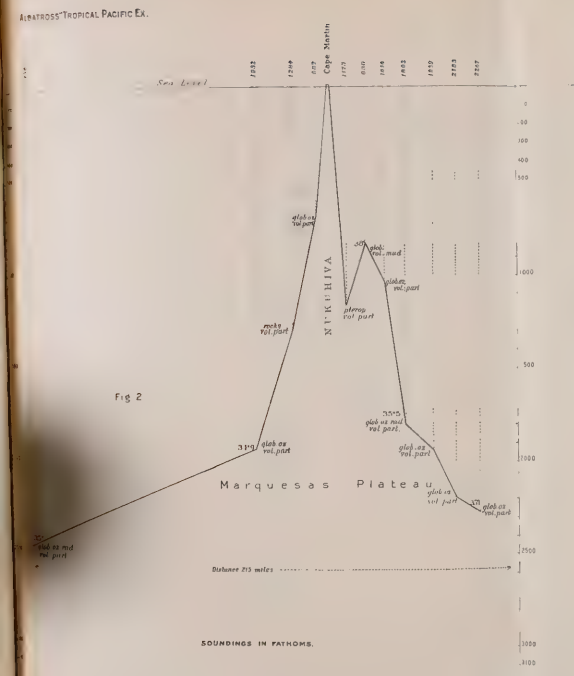
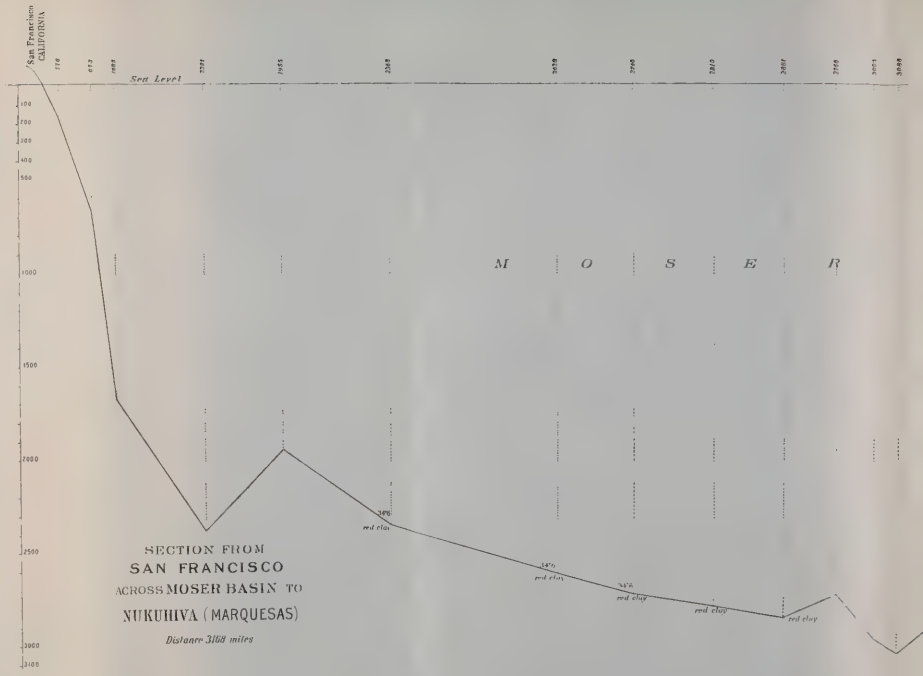


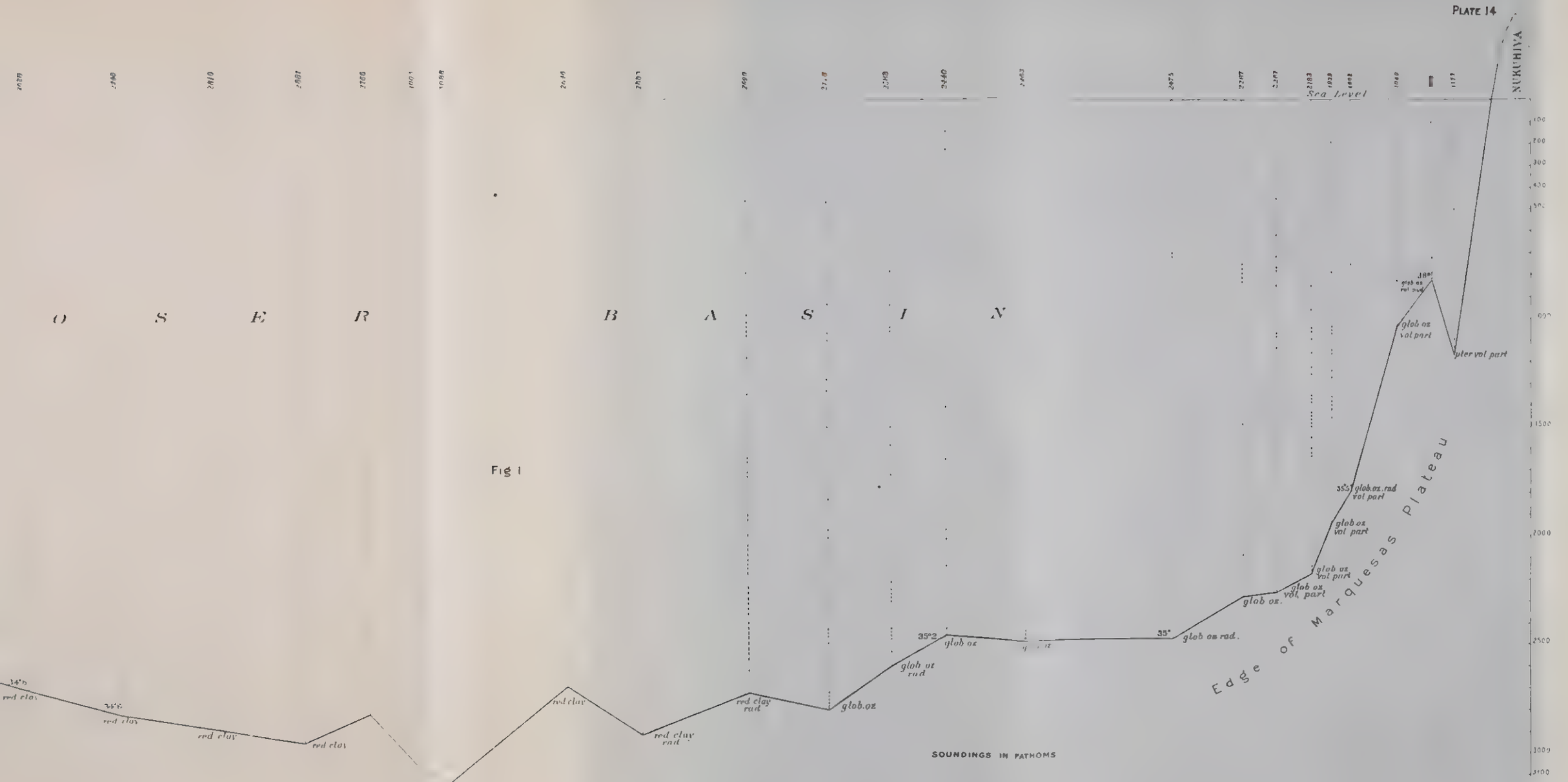
Fig 2



SECTION FROM
SAN FRANCISCO
ACROSS MOSER BASIN TO
NUKUHIVA (MARQUESAS)
Distance 3168 miles

PLATE 14

Fig 1



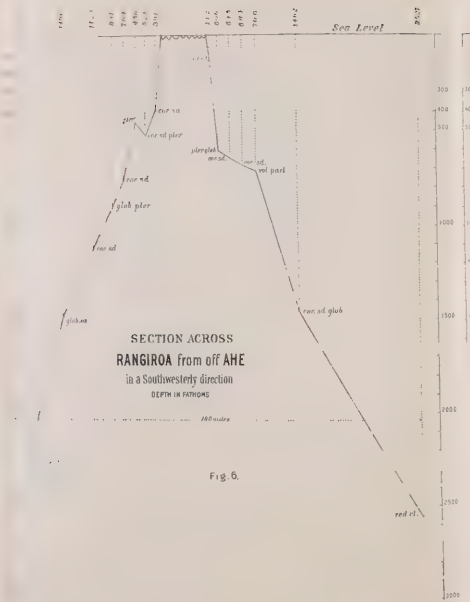


Fig. 6.

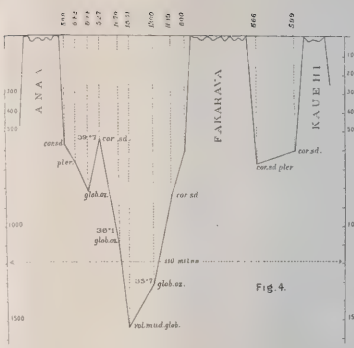


Fig. 4.

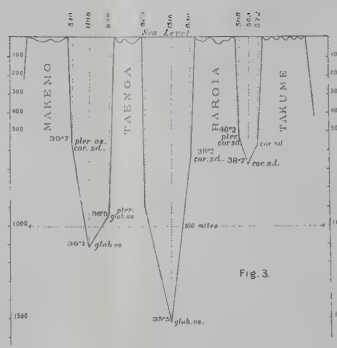


Fig. 3.

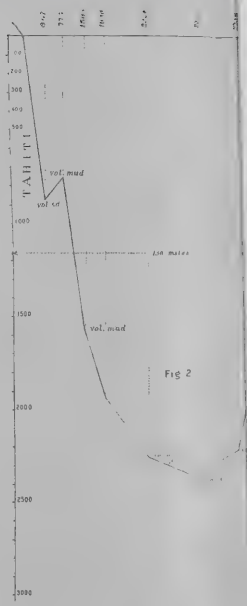


Fig. 2

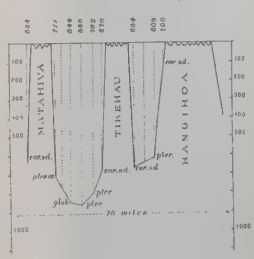
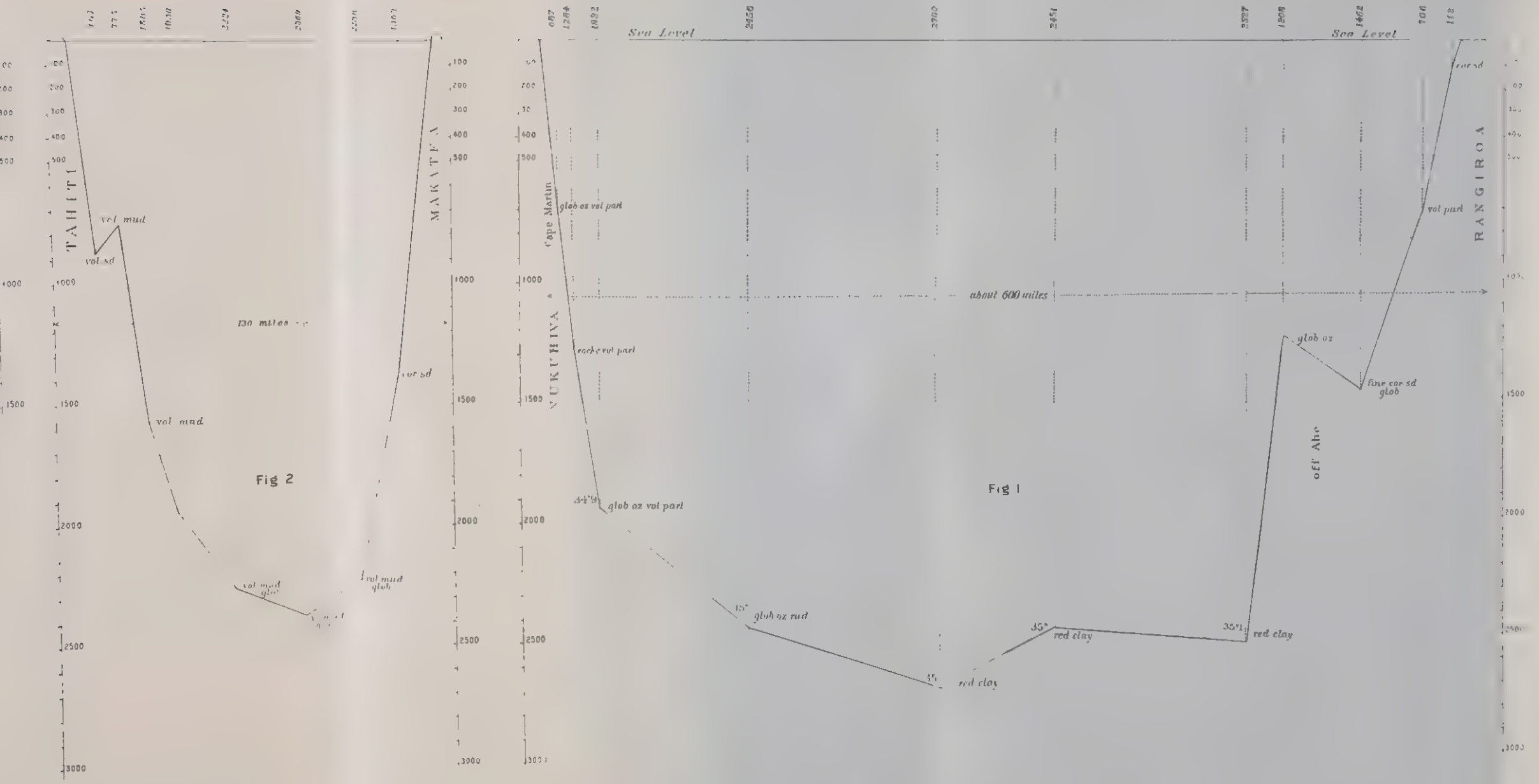


Fig 5.

SOUNDINGS IN FATHOMS.


Sea Level
Sea Level
about 600 miles
130 miles
TAHITI
MAKATEA
YUKUHIVA
RANGIROA
Cape Martin
off Ahe
glob oz vol part
rocky vol part
glob oz rad
red clay
red clay
red clay
vol mud
vol sd
vol mud
cor sd
vol mud glob
vol part
glob oz
fine cor sd glob
cor sd
Fig 1
Fig 2

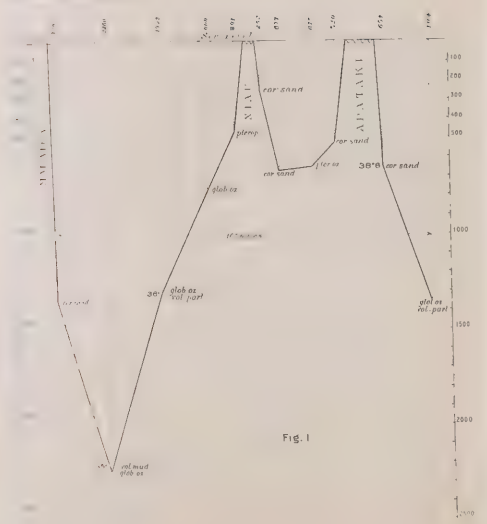


Fig. 1

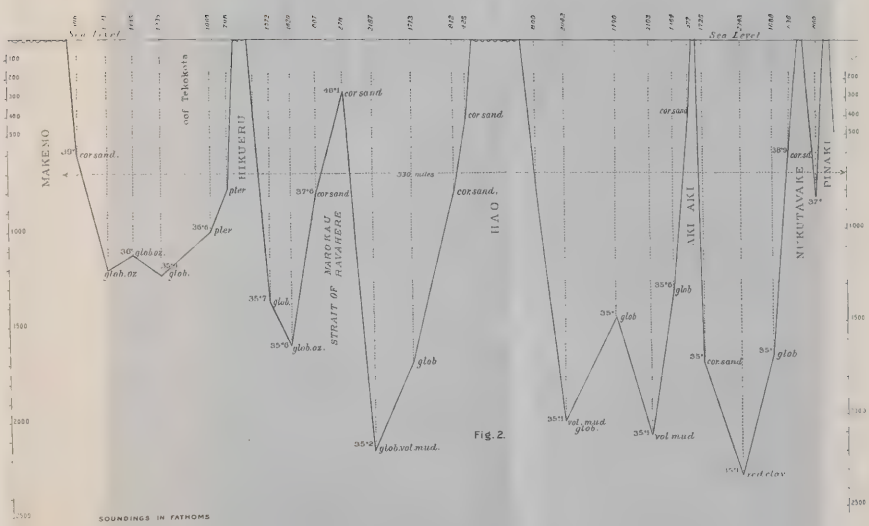


Fig. 2

SOUNDINGS IN FATHOMS

SOUNDINGS IN FATHOMS

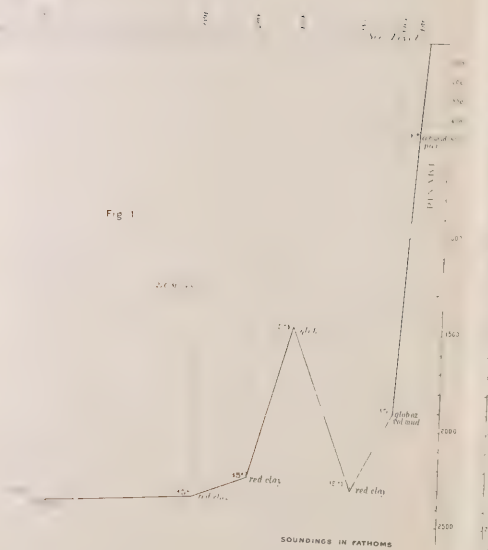

Sea Level
red clay
red clay
red clay
globig
red mud
red clay
1563
2000
2500
SOUNDINGS IN FATHOMS

Fig. 1

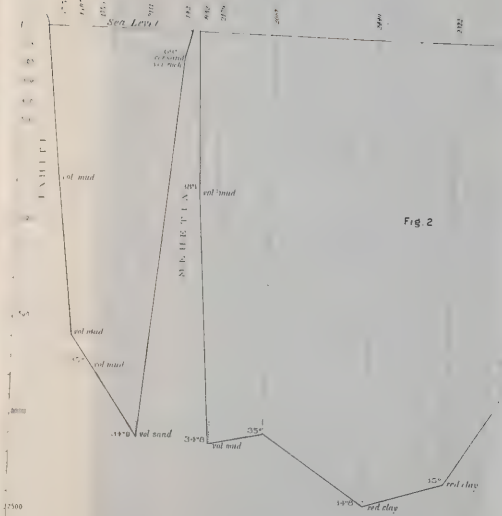
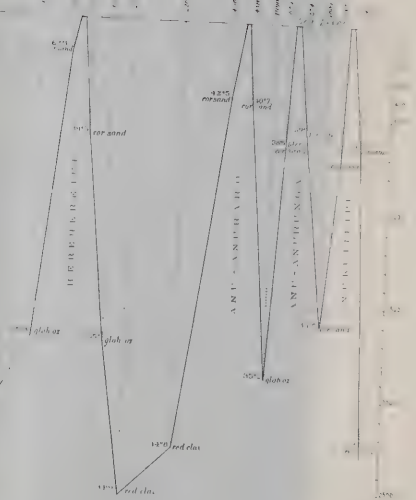

Sea Level
red mud
red mud
red mud
vol sand
vol mud
vol mud
vol mud
red clay
red clay
450 miles

Fig. 2


red sand
globig
globig
red clay
red clay
globig
red sand

SECTION FROM OFF
ROTA, LADRONE ISLANDS TO MIAKI
South of C. KING JAPAN
Distance about 1250 miles
SOUNDINGS IN FATHOMS

Line of Soundings about 120 m. West of the Ladrones

him on the principle of priority, it seems unjustifiable to cancel a name given to an oceanic ridge, or to a great basin or deep, and to substitute another because it agrees with the principles of the reformer.

Professor Supan anticipates that all maritime nations will attempt in the future to perpetuate the names of their exploring ships and their captains, and thus introduce endless confusion. But certainly the confusion can be no greater than it is in the interior of Africa, where each explorer, according to his nationality, has given the names of his eminent countrymen to the physical features of the country he traversed.

The nomenclature of the Arctic and Antarctic regions, depending absolutely upon the national geographical system, if I may so call it, is perhaps the most obvious example of the approval which civilized nations have given to the system which perpetuates the names of the hardy explorers and of the ships they commanded when pushing their way towards the poles. Bold indeed would be the man to attempt on "national grounds" to reform the names associated with so many heroic voyages. I do not mean by this in any way to compare the hardships of the Arctic voyages with those explorations which are laid in the pleasant paths of the tropics, and finally can only suggest that school children may perhaps learn a little interesting history if geographical names do not everywhere replace personal ones.

The character of the bottom of the Moser basin is most interesting. The haul of the trawl made at Station 2, lat. 28° 23′ N., long. 126° 57′ W., brought up the bag full of red clay and manganese nodules, with Tertiary sharks' teeth and cetacean ear-bones; and at nearly all our stations we had indications of the existence of manganese nodules. At Station 13, in 2690 fathoms, lat. 9° 57′ N., long. 137° 47′ W., we again obtained a fine trawl-haul of manganese nodules and red clay: there must have been at least enough to fill a forty-gallon barrel.

The nodules in our first haul were either slabs from six to eighteen inches in length and four to six inches in thickness, or small nodules ranging in size from that of a walnut to a lentil or less, while those brought up at Station 13 consisted mainly of nodules looking like mammillated cannon-balls, varying from four and a half to over six inches in diameter, the

largest being six and one half inches. We again brought up manganese nodules at the equator in about longitude 138 W., and subsequently — until within sight of Tahiti — we occasionally trawled manganese nodules.

As had been noticed by Sir John Murray in the "Challenger," these manganese nodules occur in a part of the Pacific most distant from continental areas. Our experience has been similar to that of the "Challenger," only I am inclined to think that these nodules range over a far more extensive area of the Central Pacific than had been supposed, and that this peculiar manganese-nodule bottom characterizes a great portion of the deep parts of the Central Pacific, where it cannot be affected by the deposition of Globigerinæ, Pteropods, or telluric ooze, in the region characterized also by red-clay deposits. For in the track of the great equatorial currents there occur deposits of Globigerina ooze in over 2400 fathoms for a distance of over 300 miles in latitude.

We also found manganese nodules south of the Marquesas; at Station 31, when in 2700 fathoms, we obtained perhaps the finest specimens of red clay from any of our soundings. As we approached the western Paumotus, upon the north side of the plateau from which they rise, Globigerina ooze passed gradually to Pteropod ooze, then to fine and coarse coral-sand. In the channel south of the Paumotus to Tahiti the coral sand passed to volcanic sand mixed with Globigerinæ in the deepest parts of the line, and toward Tahiti passed to volcanic mud mixed with Globigerinæ, next to fine volcanic sand, and finally, at the last sounding, off Point Venus, to coarse volcanic sand.

We made a few hauls of the trawl on our way, but owing to the great distance we had to steam between San Francisco and the Marquesas (3800 miles) we could not, of course, devote much time either to trawling or to making tows at intermediate depths. Still, the hauls we made with the trawl were most interesting, and confirmed what other deep-sea expeditions have recognized: that at great depths, at considerable distances from land and away from any great oceanic current, there is comparatively little animal life to be found. Where manganese nodules were found in abundance the hauls were specially poor, a few deep-sea Holothurians and Ophiurans, and some small Actiniæ which had attached themselves to the

nodules, with a few other invertebrates, seemed to be all that lived at these great depths, in 2500 to 2900 fathoms, far away — say from 700 to 1000 miles — from the nearest land.

The bottom temperatures of the deep Moser basin varied between 34.6 at 2628 and 2740 fathoms, to 35.2 at 2440 fathoms, and 35 at 2475 fathoms, about 175 miles from the Marquesas. At Station 23, off the Marquesas, in 1802 fathoms, the temperature was 35.5°.

Owing to the failure of many of our deep-sea thermometers, we were not able to make any satisfactory serial-temperature observations. At Station 11, lat. 14° 38′ N., long. 136° 44′ W., in 2646 fathoms, we obtained:

79° at surface.	48.9° at 200 fathoms.
78.7° " 50 fathoms[1]	44.1° " 300 "
55.9° " 100 "	39.9° " 700 "

These temperatures are somewhat higher than those obtained by the "Challenger" in similar latitudes on their line to the westward of ours between the Hawaiian Islands and Tahiti. At Tahiti a temperature of 40 is found to vary between 500 and 600 fathoms, off Hawaii a temperature of 48 obtains in 224 fathoms, at Hilo 40 was found in 400 fathoms, much colder than on the eastern lines.

The temperatures of the bottom between the Marquesas and Paumotus were 34.9 at 1932 fathoms, 35 at 2456 fathoms and 2451 fathoms, and 35.1° at 2527 fathoms.

We did not take any bottom temperatures between the Paumotus and Tahiti.

Our deep-sea nets not having reached San Francisco at the time we sailed, we limited our pelagic work to surface hauls, of which we generally made one in the morning and one in the evening, and whenever practicable, some hauls with the open tow-nets at depths varying between 100 and 350 fathoms. The results of these hauls were very satisfactory. The

[1] Off shore off San Francisco the "Albatross" observed in

Fathoms		Fathoms.	
352	53.5°	1122	35.5°
618	39°	1597	35°
867	37°	2594	34.9°

line San Francisco to Hawaiian Islands.

collection of surface animals is quite extensive, and many interesting forms were obtained. As regards the deeper hauls, they only confirm what has been my experience on former expeditions, that beyond 300 to 350 fathoms very little animal life is found, and in the belt above 300 fathoms the greater number of many so-called deep-sea Crustaceans and deep-sea fishes were obtained. I may mention that we obtained Pelagothuria at about 100 fathoms from the surface.

We trawled at Station 10 in 3088 fathoms. Unfortunately, the trawl was not successful, and we simply hauled the bag through over 3000 fathoms without bringing up a single deep-sea animal from intermediate depths which we did not obtain quite near the surface — at less than 300 fathoms. I may mention here that the experience of the "Valdivia" shows, from the preliminary reports published by Professor Chun,[1] that pelagic algæ do not extend to beyond about 150 fathoms. Although he also states that animal life is found at all depths from the surface to the bottom, yet he states that beyond 800 meters it diminishes *very rapidly;* Professor Chun does not state whether this diminution is more rapid away from land than near continental areas, both of which conditions I had called especial attention to in my Preliminary Report on the "Albatross" expedition of 1891, while using the Tanner net in the Gulf of California.[2] Mr. George Murray has criticised the action of the Tanner deep-sea net, and condemns its results, suggesting that the bottom net had always closed some time after being sent down.[3] I need not now discuss that subject, but will only refer him to the report of the "Albatross," in which he will find the closed part of the net to have on several occasions brought up (when I expected it to do so) specimens from over 600 fathoms from immediately above the bottom, or samples of the bottom from near 1700 fathoms while attempting to tow immediately above that depth. I ought, in justice to him, to state that I omitted to mention that we secured the loops by twine to the detacher to insure their dropping only when the

[1] Die Deutsche Tiefsee Expedition 1898–99. Zeits. d. Gesell. für Erdkunde zu Berlin, 1899, XXXIV., Heft 2.

[2] Bull. M. C. Z., 1892, Vol. XXIII., No. 1, pp. 40, 45.

[3] George Murray. Exploration of the intermediate depths of the ocean. Geog. Mag., XIII., No. 2, February, 1899, p. 152.

messenger reached the detacher, and that the hooks of the detacher were lengthened very considerably above the dimensions figured in my Preliminary Report on the "Albatross" expedition of 1891. I might add that we made a number of trials near the surface to see the action of the Tanner net under all conditions of position and speed, and I can only assume that Mr. Murray, having no experience, did not handle his net properly, or that it was not properly balanced. I may also add that Captain Tanner used his modified net subsequently in the "Albatross," while running a line of soundings from San Francisco to the Hawaiian Islands, in from 100 to 350 fathoms from the surface, at considerable distances from the islands and the mainland, and also in Alaskan waters, and always with the results we had obtained before. The closed bag, when towing at 100 fathoms below the surface, always brought up a mass of pelagic animals living at about that depth, while when tried at 300–350 fathoms it brought up little or nothing. There is nothing in Captain Tanner's experience,[1] — who, as commander of the "Albatross" from 1883 until 1894, has had a longer service in deep-sea explorations than any other individual, — or mine, to indicate why the net should act well at 100 fathoms and not well at 300 fathoms or more, as suggested by Mr. Murray.

Subsequently, during the winter of 1893–94 when off the northern coast of Cuba, during my cruise in the "Wild Duck"[2] I had occasion again to use the modified deep-sea self-closing Tanner net, and found no reason to change the views regarding the general bathymetrical distribution of pelagic life I had expressed in my Preliminary Report on the Results of the "Albatross" Expedition of 1891.

In the winter of 1897–98 I also made a number of hauls with the deep-sea self-closing Tanner net at several points in Fiji, the results of which will be found in my Report on the Islands and Coral Reefs of Fiji.[3]

As long as we have no better acquaintance with the surface fauna of the great oceans than we now possess, it is idle from the few hauls which have made us familiar with some of the denizens of a bathymetric belt

[1] Z. L. Tanner. On the appliances for collecting pelagic organisms. Bull. U. S. Fish Commission, Vol. XIV., 1895, p. 143.

[2] Bull. M. C. Z., XXVI., No. 1, 1894, p. 7.

[3] Bull. M. C. Z., Vol. XXXII., 1899, p. 14.

extending from the surface down to, say 300 fathoms, at the outside, to undertake to classify them into distinct series extending from the surface to great depths. What is still needed is a careful exploration of the bathymetrical range of the pelagic fauna on a line extending far out to sea from a continental slope into great depths, and a similar line along a great oceanic current far from any disturbing element such as an archipelago or submarine plateaus.

If we knew all the species of the so-called pelagic belt it would be a different thing; but when the peculiar fish with pedunculated eyes which Chun calls a deep-sea fish, and specially characteristic of intermediate depths, is found by us at 100 fathoms, this, as well as the many other fishes and so-called deep-sea Crustacea, Holothurians, Ascidians, and Medusæ which we caught at or about the 100-fathom line in this and in my former expeditions, plainly shows that as yet we are very far from knowing the species which inhabit the belt between 100 fathoms or more and the surface.[1] No deep-sea expedition using better and newer appliances has as yet failed to bring up within these limits some so-called new deep-sea species if they happen to have brought it up when dropping the net in greater depths, while the next explorer again brings it up from inside the 100-fathom line. (See note.) I still reiterate that near the bottom, and some distance above it, a certain number of so-called pelagic species undoubtedly live, as well as in proximity to the continental slopes; but that is no criterion of the mode of distribution of pelagic life at sea far away from continental areas. When thus caught

Note. — I may mention among the Fishes: Collettia, Scopelus, Myctophum, Argyropelecus, Polyipnus, Plectromus, Paralepis, Stomias, Malacosteus, Eustomias, Melamphaës, Trachichthys, Sternoptyx, Cyclothone, Gonostoma, Notoscopelus, Lampanyctus, Cyema, Caulolepis, Hoplostethus, Chaunax, and Melanocetus. Among the Crustacea: Gnathophausia, Thysanopoda, Bentheuphausia, Willemœsia, Stylocheiron, Nematoscelis, Euphausia, Syriella, Nyctiphanes, Sergestes, Benthœcetes. The remarkable Ascidian Octacnemus. The pelagic Holothurian Pelagothuria, and the greater number of the so-called deep-sea Medusæ: Atolla, Periphylla, and Nauphanta, as well as a number of so-called deep-sea Siphonophores, Bathyphysa, and the like, which are caught by the wire rope.

[1] Die Deutsche Tiefsee Expedition 1898–99, Berlin, 1899, p. 54. Zeits. d. Gesell. f. Erdkunde zu Berlin, 1899, XXIV., Heft 2.

near the land it teaches us nothing of their bathymetrical range, as they may occasionally wander off miles by being carried seaward by currents and drop off into deep water along continental slopes.

Unfortunately, the marked paucity of pelagic animal life in the Pacific makes it well-nigh impossible to obtain data for their bathymetrical distribution with the limited information we have.

On our way to Tahiti from the Marquesas we stopped a few days to examine the westernmost atolls of the Paumotus. After striking Ahii we made for Rangiroa, the largest atoll of the Paumotu Group. Skirting the northern shore from a point a little west of Tiputa Pass, we entered the lagoon through Avatoru Pass, anchoring off the village. This pass is quite narrow, with a strong current running out the greater part of the time, especially in easterly winds. It varies in depth between nine and ten fathoms, shoaling near the inner entrance to about three and one half fathoms, and deepening again to six or seven fathoms, and gradually passing into fifteen to seventeen fathoms, which is the average depth of the lagoon from Avatoru Pass across to the south or weather shore, a distance of about thirteen miles.

We made an examination of the northern side of the lagoon between Avatoru and Tiputa Passes. The lagoon beach of the northern shore is quite steep, and is composed of moderately coarse broken coral sand at the base, and of larger fragments of corals along the upper face, which is about 5 to 6 feet above high-water mark. These coral fragments are derived in part from the corals living on the lagoon face of the northern shore, and in part of fragments broken by the waves from somewhat below the low-water mark. The ledge which underlies the beach crops out at many places on the lagoon side of the northern land-rim; we traced it also along the shores of Avatoru Pass, and specially about half-way between Avatoru and Tiputa Passes across the narrow northern land-rim. It crops out also at various points between these passes in the narrow cuts which divide this part of the northern land-rim of the lagoon into a number of smaller islands. These secondary passes leave exposed the underlying ledge, full of fossil corals. In some cases these secondary passes leave a clear channel extending across from the lagoon to the northern

side, through which water flows at high or half tide. In other cases the cuts are silted up with coral sand blown in from the lagoon side. In others, the cut is shut off by a high sand-bank, or a bank composed of broken fragments of corals, leaving access to the water from the northern shore only; and finally the cuts are also shut off on the northern side by sand and broken coral banks, the extension of the north shore outer beach leaving a depression which at first is filled with salt-water and gradually silted up both from the lagoon side and the sea-side, and forms the typical north-shore land-rim of the lagoon. This building up of the land-rim of the Paumotu atolls by the accumulation of sand both from the lagoon side and the sea face, is very characteristic of the atolls of that group. It is a feature which I have not seen so marked in any other coral-reef district.

On the lagoon side the slope from the beach is very gradual into sixteen and seventeen fathoms, and corals appear to flourish on the lagoon slope to six or eight fathoms only, in some cases consisting of Madrepores, in others of Porites or of Astræans, and Pocillopores. The corals could be seen over the floor of the Avatoru passage down to from nine to ten fathoms; and on the sea face Pocillopores covered the outer edge of the shore platform. This platform is from 200 to 250 feet wide, and was formed by the planing off of the seaward extension of the ledge cropping out in the cuts.

It became very evident, after we had examined the south shore of the lagoon, that the ledge underlying the north shore is the remnant of a bed of Tertiary coralliferous limestone, which at one time covered the greater part of the area of the lagoon, portions of which may have been elevated to a considerable height. This limestone was gradually denuded and eroded to the level of the sea. Passages were formed on its outside edge, allowing the sea access to the inner parts of the lagoon limestone flat. This began to cut away the inner portions of the elevated limestone, forming large sounds, as in the case of Fiji atolls, and leaving finally on the south side only a flat strip of perhaps 2500 to 3000 feet in width, which has gradually been further eroded on the lagoon side and also on the sea face, to leave only a narrow strip of land about 1000 feet in width and perhaps ten to fourteen feet in height, the material for this land hav-

ing come from the disintegration of the ledge of Tertiary limestone, both on the sea face and the lagoon side.

There exist in the lagoon a number of small islets which also consist of this same Tertiary limestone in process of disintegration and transformation to coral-sand islets. They are the islets at the lagoon side of both Avatoru and Tiputa Passes, the two islets which we found along our line of soundings across the lagoon, the one about four and one half miles from the north side of the lagoon, and the other about the same distance from the south shore. I am told that the eastern extremity of the lagoon is filled with islets and heads consisting of the same limestone rock so characteristic of the north and south shores of the lagoon.

The underlying ledge is not the remnant of a modern reef; its character is identical with that of the elevated limestones of Fiji, which are of Tertiary age, and the rock is in every respect the same as that I observed on many of the elevated islands of Fiji. The atoll of Rangiroa is in a stage of denudation and erosion very similar to that of Ngele Levu, in Fiji, only in Ngele Levu the elevated limestone attains a height of about sixty feet. Our visit to the southern land-rim of the lagoon, both on the lagoon side and on the sea face, left us no doubt regarding the character of the underlying ledge of the north shore. As soon as the south shore land was sufficiently near, as seen from the lagoon side, for us to distinguish its character, we could see that the entire shore line was formed of a high ledge of limestone, honeycombed, pitted, and eroded by atmospheric agencies, and undercut by the action of the waves both on the lagoon side and on the sea face. The great rollers of the weather side broke through between the columnar masses of the ledge into the lagoon, and as far as the eye could reach there extended a more or less continuous wall (which is described by Dana[1] as he saw it while sailing by in the "Vincennes"). But in addition to this we found, on landing, this wall to be the sea face of the islands and islets which dot the weather side for the greater part of its length on the southwestern part of the lagoon.

These islands and islets of the weather land-rim are entirely composed of coral sand and coral fragments, formed from the disintegration of the

[1] Corals and Coral Islands, 3d ed., 1890, p. 369.

extension of the elevated ledge toward the inside of the lagoon to a distance of about one and one half to two miles; and along this very gradual inner slope of the islands forming the southern edge of Rangiroa, corals grow profusely down to six or seven fathoms of water, when the bottom runs into hard coralline bottom, similar to that found on all the soundings taken across the lagoon.

The width of the larger islands of the weather land-rim is about 1000 to 1200 feet; the smaller islands and islets are less, some of the latter forming in reality mere sand buttresses at right angles to the great limestone ledge which flanks them all on the sea face and connects them on the weather side as if by a great wall, more or less broken, and partly shuts off the communication of the interior of the lagoon with the sea on that side.

The passages between the islands and islets illustrate well, only on a larger scale, the formation of the cuts, more or less silted up, which were observed on the northern face of the lagoon. Some of these passages are dry at low-water, others are partly filled by tide pools, others are entirely silted up by lagoon sand, only they are lower than the sand-blown land of the islands on either side of it.

Crossing over to the weather side of the southern land rim of Rangiroa in one of the passages between two of the islands, we came upon the coralliferous limestone ledge, from twelve to fourteen feet high and about forty to fifty feet wide at the top, which formed the sea face of the islands and islets, and extended far to the westward as a great stone wall more or less broken into distinct parts. We found this ledge to consist of elevated limestone as hard as calcite, full of corals, honeycombed and pitted, and worn into countless spires and spurs, and needles and blocks of all sizes and shapes, separated by deep crevasses or pot-holes recalling a similar scene in Ngele Levu on the windward end of the lagoon. In the passages the parts of the ledge which had not been eroded extended as wide buttresses, gradually diminishing in height till they formed a part of the lagoon flat and extended out into the lagoon below the recent beach-rock which covered it in short stretches.

The sea-face slope of the elevated ledge was quite steep, but otherwise similar to the lagoon slope, and its upper surface weathered by atmospheric

and aqueous agencies into all possible shapes such as I have mentioned. The slope passed into the shore platform, which was shaved down, as it were, to a general level surface. On the outer edge, within the line of the breakers, were growing Pocillopores and Nullipores in great abundance. This reef flat or shore platform, as well as the reef platform of the north shore, was strewn here and there with huge masses of the ledge of elevated reef-rock torn from its outer edge. Similar rocks and bowlders occur on the lagoon side of the islands forming the outer land-rim of Rangiroa; they are either torn off from the lagoon face of the outcropping ledge, or are outlying parts of the ledge which have remained in place and have not been planed down to the base level of the reef.

The amount of water which is forced into such a lagoon as Rangiroa is something colossal, and when we observe that there are but a small number of passages through which it can find its way out again on the leeward side, it is not surprising that we should meet with such powerful currents, seven to eight knots in several cases, sweeping out of the passages on the lee side.

The islands and islets of Rangiroa are fairly well covered with low trees and shrubs and large groves of palm trees.

The atolls of Tikehau and Matahiva, which we also examined, present no features which we did not meet in Rangiroa. The first-named atoll shows the same method of formation of the land-rim by material piled up both from the lagoon side and the sea face,—material derived from the disintegration of the underlying Tertiary limestone, which crops out here and there along the sea face and the inner shores of the lagoon, or forms across the southwest face of the lagoon an irregular, disconnected part of the ring of islands and islets encircling that end of the lagoon. These islets and islands are more or less connected by fragments of the elevated limestone ledge, attesting its greater extension in past times. The outer land-rings of both these atolls are covered with vegetation. We could see in the lagoons several rocky islets, the remnants of the elevated limestone ledge.

Matahiva is interesting, as its lagoon is quite shallow; it is full of rocky islets, remnants of the underlying coralliferous limestone ledge which crops

out above the general level, and has a very narrow and shallow entrance, passable for boats only. Some of its islands are wooded and appear to have been formed by accretion of sand from the decomposing ledges of the lagoon. The outer land-rim appears as if formed by sand-banks driven in from the sea face and also driven out from the lagoon side by the action of the waves. It is evident that a lagoon such as Matahiva could readily be closed by such a process and the sea no longer have access to it, as it now has only one very narrow and very shallow boat-passage connecting the lagoon with the sea on the lee side.

It was with great interest that we approached Makatea, as it is the only high elevated island of which Dana speaks as occurring in the western Paumotus.[1] For though he mentions some others as possibly having been elevated five to six feet, yet he considered them all, as well as Makatea (Metia, or Aurora, of Dana) as modern elevated reefs. From the very description given by him of the character of the cliffs and of the surface of Makatea, I felt satisfied that it was composed of the same elevated coralliferous limestone so characteristic of the elevated reefs of Fiji, and which from the evidence of the fossils and the character of the rock, both Mr. Dall and myself have been led to regard as of Tertiary age.

As we approached the island from the northwest it soon became evident that it presented all the characteristics to which I had become so accustomed in Fiji, and, upon landing, this was found to be the case. The cliffs had the same appearance as those of Vatu Leile, Ongea, Mango, Kambara, Yangasá, and many other elevated islands of Fiji. There were fewer fossils, perhaps, but otherwise the petrographic character of the rock was identical with that of Fiji. Mr. Mayer collected upon the top of the second terrace a number of fossils similar in all respects to those we found in the Fiji elevated coralliferous limestones.

The southwestern extremity of the island slopes gradually to the sea and shows two well-defined terraces. The lines of these two terraces could, as a rule, be traced along the faces of the vertical cliffs by the presence of caverns along the lines of those levels, similar to the lines of

[1] Corals and Coral Islands, 3d ed., 1890, p. 193.

caverns indicating the line of present action of the sea at the base of the cliffs. As we steamed around the island there were distinct indications of two additional terraces on the line of the vertical cliffs on the weather side of the island. The position of these terraces was usually more clearly seen along the face of the cliffs at prominent points, where they were undercut much as I have figured them for certain cliffs in Vatu Leile, Yangasá, Mango, Fulanga, and others in Fiji, in my report on the islands and coral reefs of that group.[1]

Of course it is premature, from this examination of the western extremity of the Paumotus, to base any general conclusions regarding the mode of formation of those atolls; certainly, as far as I have gone, there is absolutely nothing to show that the atolls of the Paumotus have not been formed in an area of elevation similar to that of Fiji. The evidence in Rangiroa and in the atolls of the western Paumotus is very definite. Makatea is an elevated mass of coralliferous limestone similar in all respects to masses like Vatu Vara, Thithia, and others in Fiji. Like them, Makatea is surrounded by a comparatively narrow shore platform cut out from the base of the limestone cliffs, and on the seaward extension of which corals grow abundantly to depths of seven to eight fathoms, when they appear to become very much less numerous. So that it is not unnatural to look upon the area of the Paumotus, as I am inclined to do, as one of elevation, the raised and elevated land of which has been affected much in the same way, by denudation and by erosion, as have the masses of elevated coralliferous limestone of Fiji. Only there seems to have been, from the evidence thus far presented, a far greater uniformity in the height of the elevation of the Paumotus. This would render the explanation I have given less evident had I not the experience of the Fiji group to guide me. Evidence of this elevation is found at the two extremities of the Paumotu Plateau, at Makatea, an elevated island consisting of Tertiary coralliferous limestone, and at the Gambier Islands, which are volcanic islands of considerable height (over 1300 feet). Furthermore, as we shall see, there are other islands and atolls in the Paumotu Group showing traces of this elevation, so that I am at any rate

[1] Bull. M. C. Z., Vol. XXXIII., 1899, Pls. 80, 84, 92, 100.

justified in denying that the Paumotus as such are situated in an area of subsidence, and that subsidence has been the great factor, as is maintained by Darwin and Dana, in the formation of the characteristic atolls of the group.

It may be well to point out also that the Paumotus, like the Marquesas on one side and the Society Islands on the other, are situated upon a plateau similar to that upon which the last-mentioned groups are placed, a plateau rising from an oceanic basin which surrounds them, and which has a depth of from 2300 to 2500 fathoms, the plateau itself having a depth of 1200 to 1500 fathoms. For the differences which distinguish the plateaux of these groups I refer to the accompanying charts.

During our stay in Papeete[1] some time was spent in examining that part of the barrier reef of Tahiti which had been surveyed by the "Challenger." We found the condition of the outer slope of the reef quite different from its description as given in the "Challenger" narrative.[2] The growing corals were comparatively few in number, and the outer slope showed nothing but a mass of dead corals and dead coral bowlders beyond sixteen or seventeen fathoms, few living corals being observed beyond ten to twelve fathoms.

We also made an expedition to Point Venus, to determine, if possible, the rate of growth of the corals on Dolphin Bank from the marks which had been placed on Point Venus by Wilkes, in 1839,[3] and by MM. Le Clerc and de Bénazé, of the French navy, in 1869. We found the stones and marks as described, but in view of the nature and condition of Dolphin Bank, did not think it worth while to make a careful survey, as Captain Moser had intended to do. On examining Dolphin Bank in the steam launch I was greatly surprised to find that there were but few corals growing on it. I could see nothing but sparsely scattered heads, none

[1] Explorations of the "Albatross" in the Pacific. II. The Paumotus. [Letter No. 2, dated Papeete Harbor, Tahiti Island, November 6, 1899, to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, Washington, D. C., by Alexander Agassiz.] Am. Jour. Sci., Fourth Series, Vol. IX., No. 50, February, 1900.

[2] Voyage of the "Challenger," Narrative of the Cruise, 2d Part of Vol. I., p. 778.

[3] U. S. Exploring Expedition Narrative, Vol. II.

larger than my fist! — the top of the bank being entirely covered by nullipores. We sounded across the bank in all possible directions, and examined it thoroughly with the water-glass, and at the stage of water at which we sounded found about eighteen inches difference from the soundings indicated by the charts. It is also greatly to be regretted that Dolphin Bank was not examined, either in 1839 or in 1869, and notes made of what species of corals, if any, were growing on its surface; for an excellent opportunity has been lost to determine the growth of corals during a period of sixty years. The choice of this bank as a standard to determine the growth of corals was unfortunate, as it is in the midst of an area comparatively free from corals.

After refitting and coaling here, we left on the 5th October for a cruise in the Paumotus.

We steamed for Makatea, which we had visited on our way to Tahiti, and not only examined the island more in detail, but took a number of photographs of the cliffs of the east side, which, on our first trip, we passed late in the afternoon. We crossed the island from west to east, the path leading down from the summit of the cliffs bordering the island into a sink at least forty to fifty feet lower than the rim of either face of the island. The sink occupies a little more than one-third the length of the island. It is deeper at its southern extremity, where it is said to be seventy-five to one hundred feet below the rim of the adjoining cliffs.

It is difficult to determine if this sink is the remnant of the former lagoon of the island, or of a sound formed during its elevation; or if it has been formed by the action of rain and atmospheric agencies. The amount of denudation and erosion to which this island has been subjected is very great, as is clearly indicated by the small cañons, pinnacles, and walls of limestone, as well as by the crevasses which occur in the surface of the basin in all directions. The extent to which this action has penetrated into the mass of the island is also plainly shown by the great number of caverns which crop out at all levels along the sea face of the cliffs, some of which are of great height and extend as long galleries into the interior of the island. It is, of course, difficult, in the

face of this extensive denudation and erosion, to state positively what may be part of the ancient lagoon, or sound, and what has been carried away by atmospheric and other agencies since the elevation of the island. At the south end of the island, which is lower than the northern part, there are only two distinct terraces, while at the northern end four terraces can be traced. The southern extremity, however, is still higher than the deepest part of the central sink of the island.

From Makatea, we visited Niau, Apataki, Tikei, Fakarava, Anaa, Tahanea, Raroia, Takume, Taenga, Makemo, Tekokoto, Hikueru, Marokau, Hao, Aki-Aki, Nukutavake, going as far east as Pinaki, when we turned westward again, to Nukutipipi.

On arriving at Pinaki we decided to give up the exploration of the eastern extremity of the Paumotus, and not to make our contemplated visit to the Gambier Islands, our time having been greatly curtailed by delays at Fakarava and Makemo, from bad weather and the non-arrival of our coal supply. We therefore reluctantly turned westward again and made for the Gloucester Islands. These, as well as Hereheretue, proved most interesting; they formed, as it were, an epitome of what we had seen on a gigantic scale in the larger atolls of the western and central Paumotus. We could see at a glance in such small atolls as Nukutipipi and Anu-Anurunga the connection between structural features which, in an atoll of forty miles in length and from ten to fifteen miles in width, it was often difficult to determine.

We anchored in Fakarava and Makemo lagoons, spending a number of days in both these atolls. We usually timed our visits to the islands where we could not anchor so as to spend the day, or the greater part of the day, at these atolls, making our passages at night, and sounding whenever practicable on the way.

After leaving Tahiti we made over 100 soundings. These have shown in a general way that the western islands are probably all on a great plateau connected perhaps by the 800-fathom line; that such islands as Anaa are probably on spurs or independent smaller plateaux, separated from the main plateau by somewhat deeper water; the same may be the condition of Raroia and Takume, and of Hao and Amanu, while such

smaller and isolated islands as Tikei, Aki-Aki, Nukutavake, and Pinaki, as well as the Gloucester Islands, rise from greater depths and are isolated peaks. At any rate, these soundings indicate, as do the soundings off the Fijis, that atolls do not necessarily rise from very great depths, and that in this characteristic atoll district, atolls are found, it is true, with steep slopes, but rising from moderate depths. The slopes of these atolls would probably resemble in every respect the slopes of the elevated coralliferous limestone islands characteristic of the Lau Group in Fiji, where they have not been obliterated by erosion, denudation, and atmospheric agencies.

The deepest sounding among the Paumotus was on the line to the northward of Hereheretue in the direction of Mehetia, where we found a depth of 2524 fathoms, and a continuation of the red clay characterizing the soundings since we left Pinaki. In nearly all the soundings among the Paumotus, even at moderate depths not far from the atolls, we brought up manganese particles or small manganese nodules. The last haul, made in deep water on the way from Hereheretue, in 2440 fathoms, on the way to Mehetia, brought at least half a ton of manganese nodules, the bottom being red clay.

We steamed about 2500 miles among the Paumotus, and although we had not the advantage of the accurate surveys of the English Hydrographic charts, which made the exploration of Fiji so easy, yet from the structure of these atolls it was a comparatively simple task, by steaming around the islands and landing wherever practicable, to get a fairly good idea of their structure. We have seen nothing in this more extended examination of the group tending to show that there has anywhere been subsidence. On the contrary, the existing condition of the atolls of the Paumotus cannot, it seems to me, be explained on any other theory except that they have been formed in an area of elevation; an area of elevation extending from Matahiva on the west to Pinaki in the east, and from the Gloucester Islands on the south to Tikei on the north, although the islands in the line of Mangareva to Tahiti are separated from the other Paumotus by a deep channel, nearly 200 miles wide and more than 2400 fathoms in depth, with scattered islets and atolls extending from Mangareva to Pinaki, and northward to Puka-ruha

and beyond, islands which are not connected with the extensive plateau upon which the greater number of the Paumotu Islands to the westward of Hao rise.

All the islands we have examined are, without exception, formed of Tertiary coralliferous limestone, which has been elevated to a greater or less extent above the level of the sea, and then planed down by atmospheric agencies and submarine erosion, the greatest elevation being at Makatea (about 230 feet), and at Niau, where the Tertiary coralliferous limestone does not rise to a greater height than twenty feet. At Rangiroa it was fifteen to sixteen feet high. At other islands it could be traced only as forming the shore platform, from fifty to 250 feet wide, which forms the outer face of the Paumotus and is so characteristic a feature of the atolls of the group. In other parts the old ledge could be traced cropping up in the interior of the outer land-rim, or in the open cuts connecting the lagoon with the outer sea-face of the atolls. Everywhere the space between the outcroppings of the old ledge, as I will call the Tertiary coralliferous limestone, was filled with beach rock, or a pudding-stone, or with a breccia or conglomerate of coralliferous material consisting in part of fragments of the old ledge, and of fragments of recent corals and shells cemented together.

The appearance of the old ledge and of the modern reef-rock is so strikingly different that it is very simple to distinguish the two, even where only comparatively small fragments are found.

We did not find in the Paumotus, as in Fiji, all possible stages of denudation and of submarine erosion between islands like Vatu Vara, Naiau, Kambara, Fulanga, Ongea, Oneata, Ngele Levu, and Wailangilala, and atolls with a mere ring of surf to indicate their existence.

In the Paumotus nearly all the islands have been elevated to a very moderate height and probably to about the same height, for the old ledge forming the base of the modern structure is found exposed nearly everywhere at about low-water when it cannot be traced at a slightly greater elevation. This would readily account for the uniform height of the islands throughout the group.

But there is another element which comes into play in this group, and has an important part in shaping the ultimate condition of these atolls. At

the Fijis we have seen the submarine erosion continue until there is little left of many of the atolls beyond the merest islet or rock to indicate its structure. In the Paumotus, in the great atolls, which are perhaps only the exposed summits of parts of ridges or spurs of an extensive Tertiary coralliferous limestone bed, the land-rim of the atoll is, after having been denuded to the level of the sea, again built up from the material of its two faces, which is thrown up on the wide reef-flats both from the sea face and from the lagoon side. We do not find in the Fijis, as in the Paumotus, the wide reef-shelves which supply such masses of material from the breaking up of the outer and inner edges of the Tertiary limestone platforms, in addition to the fragments of the recent corals growing upon the flats and their slopes, which, when dead, are thrown up on the top of the reef flats and formed into shingle and sand to form a pudding-stone, or a conglomerate, or breccia, with the fragments of the old ledge.

This pudding-stone, or beach rock, is found on all the reef flats of the islands of the group. It forms great bars, at right angles usually to the shore-line, and upon the sea face of these bars is thrown up coral shingle, both old and recent, which builds up short reaches of beaches separated by wide flats through which the sea rushes at high-water, or merely covers the flats at low tide; while on the lagoon side of the wide reef-flats a similar process is going on, throwing up finer sand among the beach-rock bars and along their sides, and thus building up little by little, at first small sand-bars, then larger bars, or islets, at right angles to the shore-line, and as they become larger by accretions from both sides, they finally form islands from 1000 to 1200 feet long, according to the width of the reef flat, extending from the lagoon edge of the flat to the sea face of the atoll. The sand-bars, little by little, become covered with vegetation, and at some stages of tide appear like islands and islets situated a considerable distance within the lagoon. Whenever the material supplied both from the lagoon side and from the sea face is very abundant, the land ring becomes more or less solid, the islets become consolidated into islands, separated by narrow or wider cuts, until finally they form the larger islands which seem at first glance to form a continuous land-rim along the edge of the lagoon, but which are often seen to be separated according to local conditions by narrow

cuts, which gradually silting up finally allow no water to pass through and merely indicate the former separation of the various parts of the land.

In the lagoons of atolls of such great length as some of those of the Paumotus, like Rangiroa, Fakarava, Makemo, and Hao, which are between thirty and forty miles long, and others of less dimensions, considerable sea rises under the prevailing trades. The sea and wind generally follow the trend of the shores, both in the lagoon and along the sea face, so that the bars of beach-rock act like buttresses and collect material at their inner and outer extremities, forming the sand-bars and islets which eventually become the land rim of the lagoon. When the material is not, from local causes, very abundant, or is washed out over the flats, there are fewer islands, and often these are but mere islets or bars for long reaches of the submerged land-rim, forming the characteristic weather-faces of many of the lagoons.

Many of the lagoons are filled with shoals or ledges awash or a few feet above the sea level. These shoals are parts of the old ledge which have not as yet been eroded, and the disintegration of which has gone far to supply the material for the land of the outer rims of the atolls. In Fakarava there were no less than thirty-six islands and islets and ledges, parts of a former great flat, now broken up, existing parallel to the outer reef flat about four miles in the lagoon. Similar reef flats exist in Tahanea, where they form a secondary lagoon with two to three fathoms of water, extending nearly the whole length of the western face of the atoll. There are several large islands on this flat, and at high water they would appear, as the islands and islets of Fakarava do, as disconnected and planted in the lagoon itself. A secondary lagoon also exists in Ravahere, and in Anaa; in both these atolls the reef flat extends across one extremity of the lagoon, and does not run parallel to the longer line of the land-rim of the atoll.

The lagoons of these atolls have a general depth of thirteen to twenty fathoms. In some cases they are somewhat deeper, as is stated, but there are no measurements, the greater depths, thirty fathoms or more, being due probably to orogenic conditions. Some of the atolls are quite shallow, as at Matahiva, as well as Pinaki, where the lagoon is not more than two to three fathoms, and Takume, where it is from five to six fathoms

deep. Some of the smaller islets we visited, among which are Tikei, Aki-Aki, and Nukutavake, have no lagoons. The former has a small shallow sink in which fresh water collects, but the rim is only very slightly higher than the interior. The last two islets are apparently depressed in the centre, three to four feet below the outer bank of sand which forms the rim (about ten to twelve feet high) of the basin of the island. I was at first inclined to look upon these islands as examples of islands which had been cut down to the level of the sea and subsequently been built up by beach rock and sand in the manner described above. The existence of extensive sand dunes on two sides of the island at Pinaki, and of large dunes (estimated to be thirty-five feet high) on the south shore of Nukutavake, seems to indicate the possibility of there having been a shallow lagoon occupying the centre of Aki-Aki and of Nukutavake, and that these lagoons were gradually filled by the sand dunes, much as Pinaki is filling now.

At Pinaki (Whitsunday Island), there is no doubt that the lagoon is rapidly filling from the sand blown in by the dunes. They are from twelve to fifteen feet high, and are forcing their way in towards the lagoon, killing the pandanus and whatever vegetation there is growing on the land-rim of the lagoon. The dunes have probably filled also a second entrance to the lagoon, indicated now only by a somewhat lower level of the land-rim. Dr. Moore and Mr. Townsend, who went ashore at Pinaki, report that the lagoon is not more than three fathoms deep; they could wade over the greater part of it. Mr. Alexander counted no less than 116 islets in this small lagoon — less than a mile in diameter — islets formed of masses of dead Tridacna shells thrown up on ledge rock, on the slopes of which grew madrepores. The bottom of the lagoon is covered by Tridacna, and masses of a species of Arca live near the edge; the intervening spaces being filled with nullipores. The entrance to the lagoon is perhaps 150 feet wide, and there is a cut through the beach rock covering the old ledge giving access to the sea into the lagoon at certain stages of the tide. The water in the lagoon is quite warm.

At Pinaki, as at other atolls and islets to the eastward, there are fewer cocoanuts than on the westward atolls, and the vegetation consists

in great part of pandanus and putu trees and the usual coral-reef vegetation of the Paumotus[1] and Fijis.

The only atoll we have seen in the Paumotus the lagoon of which is entirely shut off from the sea is Niau. In this case the old ledge forming the land-rim which surrounds the nearly circular lagoon is about a third of a mile in width and sufficiently high, fifteen to twenty feet, to prevent any sea from having access to it except in case of a cyclone, as that of 1878, when the sea washed into the lagoon. The lagoon is shallow, of an average depth of about three fathoms, the deeper parts perhaps five. The water is brackish, of a density of 1.0216 at 28° C. There are no corals living in it, but a species of mullet is found, as well as many marine shells, which, like those in the lagoons of San Salvador, in the Bahamas, are of diminutive size compared to their representatives living outside. The floor of the lagoon is covered with algæ. The lagoon has probably a slight connection with the sea, the water percolating through the limestone ring separating it from the outer reef-flat. It is very difficult in this case to decide whether this lagoon has been gradually filled up after elevation, or whether it is merely a sink formed by solution and atmospheric erosion on a more or less uneven limestone surface.

Dana, and other writers on coral reefs, mention a great number of lagoons as being absolutely shut off from the sea. I take it these statements are due to their descriptions being taken from charts, many of which, as in the case of the Paumotus, are very defective. For nothing is easier than to pass at a short distance by the wide and narrow cuts which give in so many cases the freest access to the sea to the interior of the lagoon, and are described as closed because they have no boat passages. I could mention, as instances of such lagoons, those of the atolls of Takume, Hikueru, Anaa, etc., which may be said to be closed, yet into which a huge volume of water is poured at every tide over low parts of the encircling reef-flats.

The character of the coral reefs of the Paumotus is very different from that of other coral-reef regions I have seen. Nowhere have I seen

[1] See Dana, Corals and Coral Islands, 3d ed. p. 326.

such a small number of genera, so many small species, and such stunted development of the corals. None of the great heads of the genera so characteristic of the West Indian regions, or of the Great Barrier Reef of Australia, are to be seen; with the exception of a couple of species, alcyonaria are absent, so far as our experience shows, and there are but few sponges and gorgonians to be found among the corals. The bathymetrical limit of the reef-building corals seems to be about twenty to twenty-two fathoms, but nowhere have I seen such extraordinary development of incrusting nullipores as on the sea edge of the shore platforms of some of the Paumotu atolls, where they build up to a height often of four feet to form the outer edge of the secondary barrier reef so frequently seen along the sea reef-faces of the Paumotus.

Judging from the temperatures taken at various points, 40° F. seems to be found quite generally at about 500 fathoms depth.

We made a number of surface hauls, as well as intermediate hauls with the tow-nets, but obtained very little animal life in the Paumotus. The poverty of the surface pelagic life and down to 300 fathoms is remarkable. I do not think I have ever sailed over so extensive an area as that of the Paumotus and observed so little surface life; on calm days, under the most favorable conditions, nothing could be seen with the naked eye, and at night there was little or no phosphorescence. Inside of the lagoons our hauls were equally barren.

The same paucity of animal life seemed to extend to the deep-water fauna. All the hauls we made off the islands, in from 600 to 1000 fathoms, usually the most productive area of a sea slope, brought nothing, or so little that we came to grudge the time spent in trawling on the bottom, as well as towing on the surface or near it, — a great contrast to the conditions in the Atlantic in similar latitudes, and very different from our anticipations.

For these reasons we did not attempt to make a trial of the deep-sea pump while in such unproductive areas; and unfortunately while we were in the region of the equatorial currents the weather conditions were not suited for a trial of the apparatus.

We left Papeete[1] November 15th, after coaling and refitting on our return from the Paumotus. During our trip to Suva we made a few soundings from Tahiti to Tonga, striking the northern extension of the deep basin lying to the eastward of Niue; the depths ranged from 2472 to 2882, the bottom being red clay. This would indicate a greater extension westward of the zone over which the manganese-nodule bottom is known to extend.

After leaving Niue we steamed for the deep hole of the Tonga-Kermadec Deep, about seventy-five miles to the eastward of Tongatábu, and in 4173 fathoms made a haul with the "Blake" beam-trawl, by far the deepest trawl-haul yet made. The gear was carefully inspected, and strengthened as far as practicable by Captain Moser, and it was with considerable anxiety that we laid out 5000 fathoms of wire rope for our haul. Fortunately, everything went off successfully, and we landed the trawl safely back on deck. To my great surprise we found in the bag a number of large fragments of a silicious sponge belonging probably to the genus Crateromorpha, which had been obtained by the "Challenger" in the Western Pacific, but in depths less than 500 fathoms. We also brought up quite a large sample of the bottom; it consisted of light-brown volcanic mud mixed with Radiolarians.

We decided to trawl at 4173 fathoms rather than wait for a possibly deeper sounding, as the conditions for work were admirable and we did not care to run any risk from a change of weather. After our haul we made a still deeper sounding in the proximity of the 4762-fathom sounding marked on the chart, and found 4540 fathoms, with the bottom of the same character as at the place where we trawled. We also took a couple of soundings in the line from Vavau to the southern extremity of the Lau Group in Fiji, but found, as we expected from the soundings given farther south, comparatively shoal water, viz.: 1381 fathoms. In the channel north of Yangasá, where we crossed the Lau Plateau, between Yangasá and Mothe, we found 453 fathoms, with bottom composed of coral sand,

[1] Explorations of the "Albatross" in the Pacific. III. [Letter No. 3, dated Suva Harbor, Fiji Islands, December 11th, 1899, to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, Washington, D. C., by Alexander Agassiz.] Am. Jour. Sci., Fourth Series, Vol. IX., No. 51, March, 1900.

pteropod ooze, and a few Globigerinæ. Between Namuka and Yangasá we obtained 324 fathoms; between Namuka and Marambo, 600 fathoms; between it and Kambara, 450 fathoms; and finally, about fifteen miles west of Kambara, we sounded in 990 fathoms. These soundings would indicate a continuous plateau of moderate depths from Wailangilala south, upon which the islands of the Lau Group rise.

On our way back to Papeete from the Paumotus we examined the eastern cost of Tahiti, and from Papeete examined the western coast as far as Port Phaeton, at Taravoa Isthmus. We examined, in a general way, the Leeward Society Islands: Murea, Huaheine, Raiatea, Tahaa, Bora-Bora, Motu Iti, and Maupiti. There are excellent charts of the Society Islands, so that it was comparatively simple to examine the typical points of the group and to gain an idea of their structure as far as it relates to coral reefs. The Society Islands are all volcanic islands edged with shore platforms, some of great width, upon which the barrier or the fringing reefs of the islands have grown. The structure of the reefs of the Society Islands is very similar to that of the Fiji reefs round volcanic islands. A comparison, for instance, of the charts of Kandavu, Viti Levu, Mbengha, Nairai, and of other volcanic islands in the Fijis, with those of the Society Group, will at once show the identity of their structure. Huge platforms of submarine denudation and erosion characterize both, with fringing and barrier reefs determined by local conditions. Perhaps it is easier to follow the changes which have taken place in the Society Islands; and such islands as Tahaa and Bora-Bora, where we anchored, as well as Maupiti, are admirable examples and epitomes of the structure and mode of formation of the coral reefs of that group.

In Motu Iti and Tetiaroa the volcanic peaks have disappeared, leaving nothing but a shallow platform, upon the outer edges of which sandy coral islets have been thrown up. There is, however, one point in which the barrier reefs of the Society Islands differ from those of Fiji. The barrier reefs in Fiji are generally indicated merely by reef flats, upon which the sea breaks, and an occasional rocky islet or negro-head; only rarely do we find sand keys upon the fringing reefs of the islands of Fiji. In the Society Islands, on the contrary, we find the line of the barrier reefs usually well

indicated by long lines of narrow islets thrown up on the reef platforms, exactly as they are in the Paumotus. These islands and islets are usually well wooded, and thus give a very peculiar aspect to the barrier reef. In the case of Bora-Bora, Maupiti, and Aitutaki, for instance, we have a central volcanic peak of considerable height surrounded by a wide lagoon, the sea edge of which is formed by a fringe of wooded islets and islands forming a more than half-closed ring around the central island, which, in Bora-Bora and Maupiti, rise in slopes and nearly vertical walls, the former to a height of nearly 2400 feet, the other to about 800 feet.

The only island of the Cook Group which we examined was Aitutaki; as Atiu is composed of elevated limestone, and Rarotonga is volcanic, I hoped we might find that atoll to be in part volcanic and in part composed of elevated coralliferous limestone; we found it to be volcanic, an island with the structure of Bora-Bora on a smaller scale.

We anchored at Niue, an island composed of elevated coralliferous limestone showing three well-marked terraces, the lowest of not more than five to ten feet, and in many places disappearing completely, the limestone cliffs rising vertically from the sea well into the second or even the third terraces. The vertical faces of the cliffs are dotted with caverns and deeply indented by small cañons extending at right angles to the face of the shore or forming blunt headlands separating short reaches of coral-sand beaches.

The second terrace varies in height from fifty to sixty feet, the third from ninety to 100 feet. The second terrace is deeply undercut, and in the higher vertical cliffs extending into the third terrace from the sea, the former positions of the terraces are usually indicated by lines of caverns. There are corals on the sea slopes of the first terrace, extending down to ten or twelve fathoms, growing much as they are found at Makatea.

From Niue we went to the Tongas, which we found a most interesting group. The elevated Tertiary coralliferous limestones take here their greatest development, and are on a scale far beyond that of their development in the Lau Group of the Fijis, or the Paumotus. The first island of the Tongas we visited, Eua, is perhaps the most interesting of the islands composed of Tertiary elevated coralliferous limestone I have visited. From Dana's

account of it,[1] evidently given at second-hand, I expected to find an island somewhat like Viti Levu on a very much smaller scale. But as we steamed up to it from the east there could be no mistaking the magnificent face of nearly vertical limestone cliffs forming the whole eastern face of the island, and at points rising to over a thousand feet in height. At all projecting points lines of terraces were plainly marked: at the northern point three could be followed, and at the southern extremity five, with traces of a sixth perhaps.

Upon rounding the southern extremity of the island we could see that the island was composed of two ridges, running north, separated by a deep valley, the western ridge being much lower than the eastern,[2] only rising to a height a little over 500 feet. The western ridge is also composed of limestone, and at the headlands we could trace three terraces. There is a narrow shore platform along the western face, at many points of which there are blow-holes where the sea throws up spray to a considerable height, but these blow-holes are best seen off Cook Point, the southern extremity of Tongatábu.

As we steamed along the western face of Eua Island we could see the higher ridges of the eastern side rising above the lower crest of the western ridge, the slopes indicating a valley of considerable size running between them. We anchored at English Roads opposite the outlet of the drainage of the interior basin, where a small river has cut its way through a depression in the shore terrace. On landing we followed the crest of the western ridge for a few miles and could see the whole valley forming the basin of the island lying between the two ridges, at our feet; the slopes leading to the bottom are quite gentle, and the valley dips very gradually northward back of the outlet on the western shore. Nothing could show more clearly that such an island was not an elevated atoll, but a plateau which has been eroded and denuded for a long period of time by atmospheric and other agencies, and in which a deep basin-shaped valley with gentle slopes has been gouged out, — a plateau originally similar to that of Tongatábu Island and of Vavau, but of greater height and less extent.

[1] Corals and Coral Islands, 3d ed., p. 373.

[2] The western slope of the eastern ridge is partly volcanic.

To the westward of the Tonga Islands a line of volcanic islands extends nearly 200 miles, from Honga Hapai to Fanua lai, some of which have been active very recently. Falcon Island disappeared in 1898, and Letté is still active. This line of volcanoes runs at a distance of from fifteen to twenty miles parallel with the trend of the four irregularly shaped plateaux upon which rise the Tonga Islands. They are the summits of a great ridge, over 200 miles in length, sloping very gradually to the westward into deep water, and being somewhat steeper to the eastward, towards the smaller platforms from which rise the volcanic peaks of the group. The plateaux of Tongatábu, Nomuka, Haapai, and Vavau, are separated by deep valleys connecting the eastern and western flanks of the ridge. These four plateaux rise abruptly from the 100-fathom line. The extremity of the southern one is occupied by Tongatábu Island. The land behind the cliffs of its southern coast rises to a height of over 250 feet, and slopes northward very gradually to form the low land which occupies the northern coast of the island, and is, except at Mount Zion and Cook Hill, not more than from five to twenty feet above the level of the sea. At Cook Point and along the southern coast three terraces are indicated. The northern coast is deeply indented by shallow bays, full of islands, reef flats, and reef patches, on which corals grow in great profusion. For a distance of nearly ten miles northward of Nukualofa the plateau is nowhere more than fifteen fathoms deep; and a long tongue runs northward, gradually deepening into twenty to fifty fathoms to the 100-fathom line.

The Tongatábu plateau is separated from the Nomuka Group plateau by a funnel-shaped channel with a depth passing rapidly into 300 fathoms from the 100-fathom line. The Nomuka plateau is rectangular. The principal island is Nomuka, where we anchored. We found the island to be composed of Tertiary elevated coralliferous limestone, with a shallow sink, filled with brackish water, occupying the southeastern part of the island. The sink is separated by a high sand-beach, about 200 yards wide, from the sea.

Nomuka Iki, the island next to Nomuka, we found to consist, at its southern extremity, of stratified volcanic material, resembling somewhat

the so-called soapstone of Fiji. I was informed that other islands in this group, near Tonumeia, in the centre of the Nomuka plateau, were volcanic. Mango, as we could see it from our anchorage, appeared to be volcanic. So that this part of the Tongas is, like the Lau Group in Fiji, made up of islands in part volcanic and in part composed of elevated coralliferous limestone. The eastern edge of the Nomuka plateau (which we did not visit) is edged with small low islands. We merely steamed by the western islands of the Haapai Group, but close enough to see that Tongua, Kotu, and Fotuhaa, which vary in height from 120 to 200 feet, are composed of elevated limestone. The eastern flank of the Haapai plateau is edged with long, low islands, with extensive coral reefs along the reef flats of these islands.

The Haapai plateau is triangular, with isolated islands rising on the northwestern side from the deep water separating it from the Vavau plateau. It is separated from the Nomuka plateau by a narrow channel with over 300 fathoms of water.

The northernmost plateau of the broad ridge of the Tonga Islands is the Vavau plateau. This is elliptical, with a long tongue extending on the eastern face of the ridge toward the northern point of the Haapai plateau, ending in isolated banks (the Disney reef and Falcon bank), lying to the northward of the broad channel, with over 400 fathoms separating it from the Haapai Group. The Vavau Group is by far the most picturesque of the Tonga Islands. It consists of the principal island of Vavau, extending across the northern part of the Vavau plateau. Several parts of the island of Vavau, as at the southwestern extremity, at the entrance to the harbor of Neiafu, and at Neiafu, are finely terraced; four terraces are indicated there, and other flat-topped smaller islands show traces of two or three terraces. The northern edge of Vavau Island rises to a height of more than 500 feet, and slopes in a general way southward and inland. The southern shore is deeply indented by bays and sounds, and flanked by innumerable islands and islets, some of considerable height (150 to 250 feet) which gradually become smaller and smaller as they rise toward the southward and eastward, these islands having been formed from the denudation and erosion

of the greater Vavau. They form tongues of land and sea and sounds of all shapes and sizes, showing the traces of the former land connections of the islands and islets, and their disintegration on the eastward and southward by the action of the sea. The islands and islets to the southward of the main island rise from more or less extensive reef flats which stud the whole plateau, and on which corals grow in great profusion (mainly Millepora, Porites, Pavonia, Pocillopora, Fungia, and Astrea), to a depth of five to six fathoms in the sounds. In the Nomuka Group they extended in the more open waters to fourteen and sixteen fathoms.

It is evident that in the Tonga Group, which is a very extensive area of elevation, the recent corals have played no part in the formation of the masses of land and of the plateau of the Tonga Ridge, and that here again, as in the Society Islands and the Cook Islands, both also in areas of elevation, they are a mere thin living shell or crust growing at their characteristic depths upon platforms which in the one case are volcanic, in the other calcareous, the formation of which has been independent of their growth.

After coaling and refitting we left Suva[1] on the 19th of December, and arrived at Funafuti on the 23d, stopping on the way at Nurakita, the southernmost of the Ellice Islands. I was, of course, greatly interested in my visit at Funafuti, where a boring had been made under the direction of a committee of the Royal Society, in charge of Professor David, of Sydney, after the first attempt under Professor Sollas had failed. The second boring reached a depth of more than 1100 feet. This is not the place to discuss the bearing of the work done at Funafuti, as beyond the fact of the depth reached we have as yet no final statement by the committee of the interpretation put upon the detailed examination of the core obtained, and now in the hands of Professor Judd and his assistants. In addition to the above-named islands, we also examined Nukufetau, another of the Ellice Group.

[1] Explorations of the "Albatross" in the Pacific. IV. [Letter No. 4, on the Cruise of the "Albatross," dated Yokohama, Japan, March 5, 1900, to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, Washington, D. C., by Alexander Agassiz.] Am. Jour. Sci., Fourth Series, Vol. IX., No. 53, May, 1900.

After leaving Nukufetau we encountered nothing but bad weather, which put a stop to all our work until we arrived under the lee of Arorai, the southernmost of the Gilbert Islands. On our way from Taputeuea we steamed to Apamama and Maiana, which we examined, as well as Tarawa. We next examined Maraki, an atoll which is nearly closed with high beaches, having only two small boat passages leading through the narrow outer land-rims. Both Maraki and Taritari, the last island of the Gilberts which we visited, are remarkable for the development of an inner row of islands and sand-bars in certain parts of the lagoon parallel to the outer land-rim, a feature which also exists in many of the Marshall Islands atolls.

We reached Jaluit the 9th of January, and after a few days spent in coaling, we passed about three weeks in exploring the Marshall Islands, taking in turn the atolls of the Ralick Chain to the north of Jaluit: Ailinglab Lab, Namu, Kwajalong, and Rongelab, and then some of the atolls of the Ratack Chain, Likieb, Wotje, and Arhno. The atolls of the Marshall Group are noted for their great size and the comparatively small area of the outer land-rims, the land-rims of some of the atolls being reduced to a few insignificant islands and islets. In none of the atolls of the Ellice, Gilbert, or Marshall Islands were we able to observe the character of the underlying base which forms the foundations of the land areas of these groups. In this respect these groups are in striking contrast to the Paumotus, the Society Islands, the Cook Group, Niue, the Tongas, and the Fiji Islands, where the character of the underlying foundations of the land-rims is readily ascertained. But, on the other hand, these groups give us the means of studying the mode of formation of the land-rims in a most satisfactory manner, and nowhere have we been able to study as clearly the results of the various agencies at work in shaping the endless variations produced in the islands and islets of the land-rims of the different atolls by the incessant handling and rehandling of the material in place, or of the fresh material added from the disintegration of the sea or lagoon faces of the outer land-rim, or of the corals on the outer and inner slopes. It has been very interesting to trace the ever-changing conditions which have resulted in producing so many variations in the

appearance and structure of the islands and islets of the land-rims of the different groups.

The boring at Funafuti will show us the character and age of the rocks underlying the mass of recent material of which the land-rim, not only of that atoll, but probably also that of the other atolls of the group and of neighboring groups, is composed, though of course we can only judge by analogy of the probability of the character of the underlying base from that of the nearest islands of which it has been ascertained. When we come to a group like the Marshalls we have as our guide only the character of the base rock of the islands of the Carolines, which is volcanic, while Nauru[1] and Paanopa Islands, to the west of the Gilberts and to the southwest of the Marshalls, indicate a base of ancient Tertiary limestone.

The vegetation of the atolls of the Ellice, Gilbert, and Marshalls is more luxuriant than that of the Paumotus, probably from the greater rainfall, though the number of species of plants so characteristic of the western atolls is not much greater. It is only in the larger western volcanic islands — the Fiji, Samoan, and Caroline group — that we note the marked increase in the number of species of forest trees allied to those occurring still further west, over those on the eastern groups, like the Cook and Society Islands.

Owing to the continued stormy weather and the probability of not being able to land at Nauru and Paanopa while the unfavorable conditions lasted, we did not attempt to visit them.

After leaving Suva we made a number of soundings from south of Nurakita toward the Marshall Group, which, in addition to those of the "Penguin," clearly show that the Ellice Islands are isolated peaks rising from considerable depths (from 1500 to over 2000 fathoms) and that the same is the case with the Gilbert Islands. We made about thirty soundings between the atolls of the Marshalls, which appear to show that they also rise as independent peaks or ridges, with steep slopes, from 2000 to 2500 fathoms, and that the so-called parallel chains of atolls of the Marshalls, the Rolick and Ratack, are really only the summits of isolated peaks rising but a few feet above the sea-level. The Marshall Islands, as well

[1] Nauru von Dr. Augustin Krämer. Globus, Vol. LXXIV., No. 10, September, 1898.

as the Ellice and Gilbert, seem to be somewhat higher than the Paumotus, but this difference is only apparent, and is due to the difference in the height of the tides, which is very small in the Paumotus, while in the former groups it may be five, and even six feet.

From Jaluit we visited among the Carolines, the islands and atolls of Kusaie, Pingelap, Ponapi, Andema, Losap, Nama, the Royalist Group, Truk, and Namonuito, obtaining thus an excellent idea of the character of the high volcanic islands of the group from our examinations of Kusaie and of Ponapi, while the others represent the conditions of the low atolls, having probably a volcanic basis, but this was not observed at any of those we examined.

The reefs of the volcanic islands of the Carolines are similar in character to those of the Society Islands, though there are some features, such as the great width of the platforms of submarine erosion of Ponapi and of Kusaie, and the development of a border of mangrove islands at the base of the volcanic islands, which are not found in the Society Islands.

The Truk Archipelago was perhaps the most interesting of the island groups of the Carolines, and it is the only group of volcanic islands surrounded by an encircling reef which I have thus far seen in the Pacific which at first glance lends any support to the theory of the formation of such island-groups as Truk by subsidence. This group was not visited by either Darwin or Dana; and I can well imagine that an investigator seeing this group among the first coral reefs would readily describe the islands as the summits, nearly denuded, of a great island which had gradually sunk. But a closer examination will readily show, I think, that this group is not an exception to the general rule thus far obtaining in all the island groups of the Pacific I have visited during this trip; that we must look to submarine erosion and to a multitude of local mechanical causes for our explanation of the formation of atolls and of barrier and encircling reefs, and that, on the contrary, subsidence has played no part in bringing about existing conditions of the atolls of the South and Central Pacific.

Nowhere have we seen better exemplified than at Truk how important a part is played by the existence of a submarine platform in the growth

of coral reefs. The encircling reef protects the many islands of the group against a too rapid erosion, so that they are edged by narrow fringing reefs, and nowhere do we find the wide platform so essential to the formation of barrier reefs. The effect of the northeast trades blowing so constantly in one direction for the greater part of the year is of course very great; the disintegration and erosion of islands within its influence is incessant, and their action undoubtedly one of the essential factors in shaping the atolls of the different groups, not only according to the local position of the individual islands, but also according to the geographical position of the groups. Thus far I do not think any observer has given sufficient weight to the importance of the action of the trades in modifying the islands within the limits of the trades; nor has it been noticed that the coral reefs are all situated practically within the limits of the trades, both north and south of the equator. It is interesting to note that there are no coral reefs in two extensive island groups of the Pacific, the Marquesas and the Galapagos, both within the tropics in the same latitudes where far to the westward the Gilbert and other Line islands, as well as the Ellice and Solomon Islands, are noted for the abundance of corals and the great development of coral reefs. At the Galapagos and Marquesas, corals exist only in patches, forming short stretches of fringing reefs, and it is difficult to account for the absence of coral reefs in these groups except on the supposition that the shores are usually too steep, that no great platforms of submarine erosion flank the islands, and finally that the shore cliffs and slopes are readily disintegrated by the action of the sea and afford no permanent foothold to growing corals.

The soundings made going west from Jaluit to Namonuito indicate that there is no great plateau from which the Carolines rise, but that the various groups are, as is the case with the neighboring groups of the Marshalls and Gilberts, isolated peaks with steep slopes rising from a depth of over 2000 fathoms. The line we ran from the northern end of Namonuito to Guam developed the eastern extension of a deep trough running south of the Ladrones. The existence of this trough had been indicated by a sounding of 4475 fathoms to the southwest of Guam made by the "Challenger." We obtained, about 100 miles southeast of

Guam, a depth of 4813 fathoms, a depth surpassed only, if I am not in error, by three soundings made by the "Penguin" in the deep trough extending from Tonga to the Kermadecs, and by two still deeper made by the U. S. S. "Nero"[1] to the eastward of Guam, probably in continuation of the same "Deep" called the "Caroline Deep" by Professor Supan.[2]

I was very much surprised, in approaching Guam from the eastward, to find that the island was not wholly volcanic, but that the northern half consists of elevated coralliferous limestone. The vertical cliffs bordering the eastern face rise to a height of 100 to 250 or 300 feet at the northern extremity, and resemble in every way those of similar limestone islands, such as Makatea, Niue, Eua, Vavau, and others in the Fijis, which had made their cliffs a familiar feature in our explorations. In fact, outside of Viti Levu and Vanua Levu, this is the largest island known to me where we find a combination of volcanic rocks and of elevated coralliferous limestone. The massif forming the southern half of the island is volcanic, and the highest ridge, rising to about 1000 feet, runs parallel to the west coast, the longest slope being toward the east.

This volcanic mass has burst through the limestone near Agaña, and the outer western extension of the coralliferous limestone exists only in the shape of a few spurs running out from the volcanic mass, the largest of which are those forming the port of San Luis d'Apra. These spurs are separated by lower ridges of volcanic rocks extending to the sea from the main central mass. To the north of Agaña the limestone forms an immense irregular mesa, cut by deep crevasses, full of pot-holes and sinks, rising gradually northward to a height of 350 or 400 feet. Near the northern extremity of the island a volcanic mass, Mt. Santa Rosa, has burst through the limestone and rises about 150 feet above the general level of that part of the island. The shore stratification of the bluffs is much distorted in the vicinity of that volcanic outburst.

The formation of huge masses of limestone in which occur at intervals

[1] The deep soundings of the "Nero" have been marked "Nero Deep" in H. O. Chart No. 529, published June, 1900, but it does not give the deep sounding of the "Challenger" to the westward (4475 fathoms), which was the first indication of the probable existence of a deep trough south of Guam.

[2] Petermann's Mitteil., 1899, Vol. 45, VIII., p. 180.

layers of corals or of reef-building corals must have taken place in areas of subsidence. — the subsidence taking place at a comparatively slow rate while the coralliferous belts were deposited, and at a more rapid rate at a greater depth than that at which corals could grow while the non-coralliferous limestones were laid down. This process has nothing in common with the formation of atolls. But when these coralliferous masses of limestone of great thickness were elevated either suddenly or intermittently to heights of more than 1000 feet, the resulting islands in the former case must have represented either a bed deposited near the surface — if coralliferous — enclosing perhaps a lagoon, or a sound, or a basin of solution and erosion, formed in comparatively modern times, with recent corals forming a capping of moderate thickness. In the second case, during each stage of rest the elevated beds were subject to denudation and erosion by the action of the sea. If each stage was an elevation of more than the depth at which corals can grow, the denudation and erosion may have continued long enough to cut the elevated limestone down to, or nearly down to the terrace which marks the uprising of the mass. Or the denudation and erosion may merely have gone far enough to open the circumscribed area to the action of the sea at some points only, and thus to connect what was the lagoon or basin at the first sea-level with the lagoon or basin or sound of the second stage of rest.

One can readily see how complicated the resultant action may become when we take into account the varying height of the different stages of elevation, the condition of the limestone mass and of the coralliferous limestones after the elevation, and the action of denudation and of erosion upon the elevated mass, as well as the solvent action taking place on the summit and sides, and finally the eroding action of the sea upon the interior basin, should it once break through the outer rim of the elevated basin, when its lowest point has reached the level of the sea. This break would thus form an entrance to the lagoon, much as is formed the entrance to any lagoon or sound. Should this mass be elevated a second, a third, or a fourth time, we may find one, or two, or more entrances to the old lagoons and sounds according to the rate of denudation and of erosion of the elevated mass during the periods of rest.

The coralliferous limestone rings would be fairly continuous in case of a slow rate of denudation and erosion; if broken through by the action of the sea and with a rapid rate of denudation, only disconnected patches, more or less numerous, according to the rate of erosion, would indicate the former ring; and finally, with a very rapid denudation and erosion, both of the exterior face and interior of the lagoon, or sound, nothing would be left of the elevated mass except the submerged reef-ring. This becomes still more complicated when the limestone mass, while elevated, has been broken through by the underlying volcanic rocks, and when they have displaced portions of the coralliferous limestone beds and left them more accessible to the effects of denudation and of erosion, especially when this action has taken place on the outer face of the elevated mass, and left broken cuts and openings forming connections between the outer sea and the interior basins, which would thus soon be transformed into great sounds or lagoons. The erosive as well as the solvent action of the sea would soon level the outer rim to the plane of the sea level, the further disintegration being stopped by the growth of recent corals or of coralline algæ upon the surface of the coralliferous or massive limestone eroded to the level of the sea or below it. With the more rapid erosion and denudation, both atmospheric and marine, of the limestones, they would rapidly disappear, and there would be left only the volcanic mass which had uplifted the limestones, with here and there a remnant of them to indicate the probable course of events. Of course, when the volcanic masses come up without elevating any limestone beds the conditions are much simpler, and it becomes only a question of the mode of formation of the recent corals around the base of the elevated volcanic mass.

The want of continuity of the atolls of the eastern Paumotus of the Ellice, Gilbert, and Marshall Islands, their separation by considerable distances and great depths, would seem to preclude the idea of the formation of the Tertiary limestones over great areas. The existence of these limestones on disconnected and isolated islands would suggest the formation of the limestones upon mounds or ridges elevated to very different heights below the surface of the ocean, — these mounds and ridges consisting of volcanic or other rocks elevated by the volcanic agencies which

we know to have been active over very extensive areas of the Pacific from Tertiary times to the present day. Yet in some of the Pacific archipelagos the areas upon which the Tertiary limestones were deposited must have been of considerable extent, as for instance the plateau of the northwestern Paumotus, the plateau of the Tonga Islands, and the plateau upon which the eastern islands of the Fiji Archipelago rise: the so-called Lau or Windward group of Fiji. Conditions similar to those under which the central Pacific Tertiary limestones were deposited must have been of wide geographical range; they appear, in addition, in the Philippines, in the Loyalty, the New Hebrides, and Solomon Islands, in New Caledonia, in the China Sea, at Christmas Island, in the Indian Ocean, in the Red Sea, and in the West Indian area.

We left Guam in time to reach Rota by day, and found that this island also is a mass of elevated coralliferous limestone, the highest cliffs of which reach a height of 800 feet. Perhaps in none of the elevated islands have we been able to observe the terraces of submarine elevation as well as at Rota, especially in the small knob at the southwest point of the peninsula separating Sosanlagh and Sosanjaya bays, which itself is also terraced; no less than seven distinct terraces could be traced. There was no sign of any volcanic outburst except at the northwest point of the island, where both the character of the slope and of the vegetation would seem to indicate a volcanic structure.

It is quite probable that others of the Ladrones, like Saipan and the islands to the south, are composed in part at least of elevated limestone, judging from the hydrographic charts and the sketches which accompany them.[1] On many of the northern Ladrones there are active volcanoes, so that it is very possible that the volcanic outbursts which have pushed through the limestones, or have elevated parts of the islands of the group, are of comparatively recent date.

During the last part of our cruise, from Suva to Guam, the unfavorable weather greatly interfered with our deep-sea and pelagic work; in fact, with the exception of the soundings made to develop as far as practicable the depths in the regions of the various coral-reef groups we visited, we

[1] H. O. Chart No. 1748.

abandoned all idea of carrying out the deep-sea and pelagic work planned for the district between the Gilbert and Marshall and Caroline groups. To our great disappointment hardly any marine work could be accomplished, and our investigations were limited almost entirely to the study of the coral reefs of the regions passed through.

After Mr. Townsend's departure, Dr. Moore continued to collect the birds of the islands where we anchored, and they have brought together a fairly typical collection of the avifauna of the South Sea Islands. Dr. Pryor collected the characteristic plants, and Dr. Mayer the insects and reptiles, in addition to such pelagic work as could be done in port. My private assistants, Dr. W. McM. Woodworth and Dr. A. G. Mayer, as well as my son Maximilian, took a large number of photographs, and we must have at least 900 views illustrating the coral reefs of the Pacific. Dr. Woodworth also collected incidentally such ethnological material as could readily be obtained during our short stay at different places.

We were everywhere received with the greatest cordiality and courtesy: by the Governor of the Paumotus, the King of Tonga, Sir George O'Brien (the High Commissioner of the Western Pacific at Suva), Mr. E. Brandeis (the Landes-Hauptmann in charge of the Marshall Islands at Jaluit), the Governor of the Carolines, and the Japanese authorities. The State Department at Washington having kindly asked through the French, English, German, and Japanese Embassies at Washington for the kind offices of the representatives of these nations in Oceania to the "Albatross" while in their respective precincts, thanks to these credentials nothing could exceed the interest shown everywhere in the success of our expedition.

I must also thank Captain Moser and the officers of the "Albatross" for the untiring interest shown by them during the whole time of our expedition in the work of the ship, which was so foreign to the usual duties of a naval officer.

LIST OF THE OFFICERS OF THE UNITED STATES FISH COMMISSION STEAMER "ALBATROSS."

Commander Jefferson F. Moser, U. S. N., *Commanding.*
Lieutenant Hugh Rodman, U. S. N., *Executive Officer and Navigator.*
Ensign B. K. McMorris, U. S. N., *Chief Engineer.*
" A. J. Hepburn, U. S. N.
" Cyrus R. Miller, U. S. N.
" C. S. Kempff, U. S. N.
Assistant Surgeon, J. C. Pryor, U. S. N.
Assistant Pay Master, Grey Skipwith, U. S. N.
Harry Clifford Fassett, U. S. F. C., *Captain's Clerk.*

Scientific Staff.

Charles H. Townsend, *Assistant*, U. S. F. C.
Dr. H. F. Moore, *Resident Naturalist*, U. S. F. C.
A. B. Alexander, *Fishery Expert*, U. S. F. C.

NOON POSITIONS OF THE UNITED STATES FISH COMMISSION STEAMER "ALBATROSS" DURING HER CRUISE IN THE TROPICAL PACIFIC,

AUGUST, 1899–MARCH, 1900.

SAN FRANCISCO, CALIFORNIA, TO NUKUHIVA, MARQUESAS ISLANDS.

Date. 1899.	Time.	Distance in Miles Noon to Noon.	Position.
Aug. 23	6 06 P.M.		Left San Francisco, California.
24	Noon.	132	35° 53′ N. 123° 29′ W.
25	Noon.	183	32° 57′ 124° 28′
26	Noon.	154	30° 30′ 125° 16′
27	Noon.	158	28° 30′ 127° 01′
28	Noon.	144	26° 37′ 128° 40′
29	Noon.	156	24° 33′ 130° 24′
30	Noon.	166	22° 17′ 132° 13′
31	Noon.	149	20° 12′ 133° 37′
Sept. 1	Noon.	147	18° 16′ 135° 05′
2	Noon.	120	16° 40′ 136° 14′
3	Noon.	129	14° 34′ 136° 41′
4	Noon.	158	11° 59′ 137° 19′
5	Noon.	147	9° 57′ 137° 47′
6	Noon.	105	8° 08′ 137° 37′
7	Noon.	115	6° 30′ 137° 00′
8	Noon.	123	4° 24′ 136° 55′
9	Noon.	120	2° 27′ 137° 22′
10	Noon.	112	1° 00′ 138° 00′
11	Noon.	145	1° 27′ S. 138° 01′
12	Noon.	157	4° 03′ 138° 30′
13	Noon.	155	6° 35′ 138° 59′
14	Noon.	145	8° 39′ 139° 42′
15	9.30 A.M.	48	Arrived at Taï-o-haé, Nukuhiva Island, Marquesas Group.

MARQUESAS ISLANDS TO TAHITI, SOCIETY ISLANDS, VIA NORTHWESTERN PAUMOTUS.

Sept. 17	12.30 P.M.		Left Taï-o-haé, Nukuhiva Island, Marquesas Group.
18	Noon.	152	10° 33′ S. 142° 02′ W.
19	Noon.	168	12° 15′ 141° 15′
20	Noon.	135	13° 50′ 115° 53′
21	10.05 A.M.	141	Arrived at Avatoru Pass, Rangiroa Island, Paumotu Group.
24	6.40 A.M.		Left Avatoru Pass, Rangiroa Island, Paumotu Group.
	10.00 A.M.–3.41 P.M.		Coasting off Rangiroa Island.
	Noon.	25	15° 00′ S. 148° 02′ W.

Date. 1899.	Time.	Distance in Miles Noon to Noon.	Position.
Sept. 25	8.00–9.48 A.M.		Coasting off Tikehau Island.
	Noon.	102	15° 01′ S. 148° 29′ 30″ W.
	2.30–6.00 P.M.		Coasting off Matahiva Island.
26	11.28 A.M.	104	Arrived at Makatea Island.
	6.00 P.M.		Left Makatea Island.
27	Noon.	132	17° 23′ S. 149° 24′ W.
	3.45 P.M.	8	Arrived at Papeete, Tahiti.
	THROUGH THE PAUMOTU ARCHIPELAGO.		
Oct. 5	6.00 A.M.		Left Papeete, Tahiti.
	Noon.	17	17° 18′ S. 149° 31′ W.
	1.30–2.30 P.M.		Coasting off Tetiaroa Island.
6	7.45 A.M.	122	Arrived at Makatea Island.
	3.07 P.M.		Left Makatea Island.
7	8.37 A.M.	122	Arrived at Niau Island.
	Noon.		Left Niau Island.
	5.20 P.M.		Arrived Pakaka Pass, Apataki Island.
8	9.45 A.M.		Left Pakaka Pass, Apataki Island.
	Noon.	59	15° 24′ S. 146° 25′ W.
9	Noon.	109	14° 57′ 144° 40′
	12.55 P.M.		Arrived at Tikei Island.
	11.15 P.M.		Left Tikei Island.
10	8.30 until 10.45 A.M.		Coasting off Kauehi Island.
	Noon.	106	16° 00′ S. 145° 19′ W.
	3.30 P.M.	30	Arrived at Rotoava, Fakarava Island.
14	7.00 A.M.		Left Rotoava, Fakarava Island.
	Noon.	22	16° 09′ S. 145° 49′ W.
15	9.00 A.M. until Noon.	109	Coasting off Anaa Island.
15	7.40 P.M. until		Lying to and coasting off Tahanea Island.
16	11.05 P.M.		
	Noon.	101	16° 47′ S. 144° 40′ W.
	3.40–4.05 P.M.		Coasting off Tuanaka Island.
17	Noon.	151	15° 56′ S. 142° 30′ W.
	1.00–2.00 P.M.		Coasting off Raroia Island.
17	2.50 P.M. until		Lying to and coasting off Takume Island.
18	5.30 A.M.		
	8.00–11.35 A.M.		Coasting off Raroia Island.
	Noon.	85	16° 11′ S. 142° 37′ W.
18	4.30 P.M. until		Lying to and coasting off Taenga Island (Hepuhepuarua Anchorage).
19	2.30 A.M.		
	11.50 A.M.	98	Arrived at Makemo Lagoon.
25	4.35 P.M.		Left Makemo Lagoon.
26	8.07–9.40 A.M.		Coasting off Tekokoto Island.
	Noon.	92	17° 33′ S. 142° 41′ W.
	1.20 P.M.		Arrived at Hikueru Island.
27	Noon.	16	Off Hikueru Island.
	6.18 P.M.		Left Hikueru Atoll.
28	5.55 A.M. until 5.20 P.M.		Lying to and coasting off Marokau Island.
	Noon.	51	Off West coast Marokau Island.
29	6.19 A.M. until 6.15 P.M.		Lying to and coasting off Hao Island.
	Noon.	89	Off West coast Hao Island.

Date. 1899.	Time.	Distance in Miles Noon to Noon.	Position.
Oct. 30	10.30 A.M. until 8.10 P.M.		Lying to and coasting off Akiaki Island.
	Noon.	113	Off West coast Akiaki Island.
31	7.28 A.M. until 12.05 P.M.		Lying to and coasting off Nukutavake Island.
	Noon.	64	S. W. point Nukutavake Island.
	1.40 P.M. until 5.35 P.M.		Lying to and coasting off Pinaki Island.
Nov. 1	Noon.	131	19° 50′ 30″ S. 140° 33′ W.
2	10.23 A.M. until 11.30 A.M.		Coasting off Nukutipipi Island.
	Noon.	160	20° 42′ S. 143° 03′ W.
	2.10–3.30 P.M.		Coasting off Anu-Anurunga Island.
	6.12–6.50 P.M.		Coasting off Anu-Anuraro Island.
3	9.30 A.M. until 1.50 P.M.		Lying to and coasting off Hereheretue Island.
	Noon.	131	Off West coast Hereheretue Island.
4	Noon.	105	18° 55′ S. 146° 32′ W.
5	8.30 A.M. until 12.20 P.M.		Lying to and coasting off Mehetia Island.
5	Noon.	108	Off N. W. coast Mehetia Island.
6	11.50 A.M.	126	Arrived at Papeete, Tahiti.

SOCIETY ISLANDS TO TONGATÁBU, TONGA ARCHIPELAGO, VIA LEEWARD, SOCIETY, AND COOK GROUPS, AND NIUE ISLAND.

Nov. 15	10.40 A.M.		Left Papeete, Tahiti.
	Noon.	8	17° 29′ S. 149° 43′ W.
	2.30–8.51 P.M.		Lying to and coasting off Murea Island.
16	8.00–10.00 A.M.		Coasting off Huaheine Island.
	Noon.	112	16° 38′ S. 151° 18′ W.
	6.10 P.M.		Arrived at Hurepiti Bay, Tahaa Island.
17	6.15 A.M.		Left Hurepiti Bay, Tahaa Island.
	11.40 A.M.	26	Arrived at Bora Bora Island.
18	7.10 A.M.		Left Bora Bora Island.
	9.30–10.20 A.M.		Coasting off Motu Iti.
	Noon.	27	16° 22′ S. 152° 03′ W.
	2.30–3.00 P.M.		Coasting off Maupiti Island.
19	Noon.	146	17° 12′ S. 154° 21′ W.
20	Noon.	156	17° 48′ 157° 00′
21	11.20 A.M.	176	Arrived off North coast Aitutaki Island.
	5.47 P.M.		Left Aitutaki Island.
22	Noon.	156	18° 54′ S. 162° 26′ W.
23	Noon.	154	19° 00′ 165° 00′
24	Noon.	155	19° 04′ 167° 41′
25	10.15 A.M.	137	Arrived off Alofi Village, Niue Island.
	6.20 P.M.		Left Alofi Village, Niue Island.
26	Noon.	156	20° 10′ S. 171° 54′ W.
27	Noon.	114	21° 18′ 173° 34′
28	7.10–11.15 A.M.		Coasting off Eua Island.
	11.15 A.M.	105	Arrived English Roads (Ohonua village), Eua Island.
29	6.20 A.M.		Left English Roads (Ohonua village), Eua Island.
	9.23 A.M.	26	Arrived Nukualofa, Tongatábu Island, Tonga Islands.

THROUGH TONGA ARCHIPELAGO, AND TO SUVA, FIJI ARCHIPELAGO.

Date. 1899	Time.	Distance in Miles Noon to Noon.	Position.
Dec. 1	7.00 A.M.		Left Nukualofa, Tongatábu Island, Tonga Islands.
	Noon.	34	21° 38′ S. 175° 06′ W.
	5.15 P.M.	28	Arrived at Nomuka Island.
3	12.30 P.M.		Left Nomuka Island.
4	9.10 A.M.	119	Arrived at Neiafu, Vavau Group, Tonga Islands.
5	4.15 P.M.		Left Neiafu, Vavau Group, Tonga Islands.
6	Noon.	152	18° 43′ S. 176° 31′ W.
7	Noon.	140	18° 56′ 178° 49′
	2.20 P.M.		Arrived at Kambara Island, Fiji.
8	Dropped.		
9	7.25 A.M.		Left Kambara Island, Fiji.
	Noon.	42	18° 58′ S. 179° 31′ W.
10	7.25 A.M.	147	Arrived at Suva, Fiji.

FIJI ISLANDS, THROUGH ELLICE AND GILBERT CHAINS, TO JALUIT, MARSHALL ARCHIPELAGO.

Dec. 19	9.15 A.M.		Left Suva, Fiji.
	Noon.	22	18° 10′ S. 178° 42′ E.
20	Noon.	180	16° 11′ 179° 08′ W.
21	Noon.	195	13° 00′ 179° 42′
22	Noon.	136	Off Nurakita Island, Ellice Group.
23	Noon.	154	Off North coast Funafuti Island, Ellice Group.
25	2.20 P.M.	10	Arrived at Fongafale, Funafuti Island.
26	6.20 A.M.		Left Fongafale, Funafuti Island.
	Noon.	42	8° 09′ S. 178° 42′ E.
	2.45–4.45 P.M.		Coasting off Nukufetau Island.
27	Noon.	150	6° 10′ S. 177° 20′ E.
	12.30 P.M.		Ran past Niutao Island.
28	Noon.	76	4° 52′ S. 176° 54′ E.
29	Noon.	137	South shore of Arorai Island, Gilbert Group.
	7.00 P.M.		Left Arorai Island.
30	Noon.	94	1° 43′ S. 175° 48′ E.
31	3.30–7.00 P.M.		Lying to off South coast of Onoatoa Atoll.
	11.20 A.M. until		Coasting off Taputeuea Atoll.
	2.50 P.M.		
	Noon.	130	Off N. E. coast Taputeuea Atoll.
1900			
Jan. 1	Noon.	156	00° 35′ N. 174° 02′ E.
	12.20–10.00 P.M.		Lying to and coasting off Apamama Atoll.
2	11.20 A.M. until		Coasting off Maiana Atoll.
	Noon.		
	Noon.	98	Off N. E. point Maiana Atoll.
2	5.00 P.M. until		Lying to off South coast Tarawa Atoll.
3	9.45 A.M.		
3	Noon.	40	1° 17′ N. 173° 09′ E.
	1.00–5.00 P.M.		Coasting along Tarawa Atoll.
	6.15 P.M. until		Lying to off South coast Apaiang Atoll.
4	8.00 A.M.		
	Noon.	55	1° 56′ N. 173° 16′ E.
	1.00–8.00 P.M.		Lying to and coasting off Maraki Atoll.

Date. 1900	Time.	Distance in Miles Noon to Noon.	Position.
Jan. 5	7.50 A.M.–Noon.		Coasting off South coast Taritari Atoll.
	Noon.	111	Off Entrance, West coast Taritari Atoll.
	1.20 P.M.	8	Arrived at Butaritari, Taritari Atoll.
7	7.30 A.M.		Left Butaritari, Taritari Atoll.
	Noon.	31	3° 27′ N. 172° 33′ E.
8	Noon.	120	4° 34′ 171° 55′
9	Noon.	124	Off S. E. Coast Jaluit Island, Jaluit Atoll, Marshall Islands.
	1.24 P.M.	8	Arrived at Jaluit, Jaluit Atoll.
	THROUGH MARSHALL ARCHIPELAGO.		
Jan. 14	10.00 A.M.		Left Jaluit, Jaluit Island.
	Noon.	24	Off Pingelap Island, Jaluit Atoll.
15	9.00 A.M. Noon.		Coasting off Elmore Atoll.
	Noon.	113	Off Wotje Island, Elmore Atoll.
	5.20–6.00 P.M.		Coasting off Namu Atoll.
16	8.00 A.M. until 8.00 P.M.		Coasting off Kwajalong Atoll.
	Noon.	132	Off Legan Island, Kwajalong Atoll.
17	Noon.	153	10° 52′ N. 166° 55′ E.
	4.30 P.M.		Arrived at Rongelappelap Island, Rongelab Atoll.
18	10.35 A.M.		Left Rougelappelap Island.
	Noon.	32	Off South Pass, Rongelab Atoll.
19	Noon.	105	10° 12′ N. 168° 11′ E.
20	8.10 A.M. until 1.00 P.M.		Coasting off Likieb Atoll.
	Noon.	80	Off S. W. Point Likieb Atoll.
	1.47 P.M.		Arrived at Likieb Island, Likieb Atoll.
21	9.00 A.M.		Left Likieb Island, Likieb Atoll.
	Noon.	33	9° 43′ N. 169° 26′ E.
	6.04 P.M.		Arrived Rurick Pass, Wotje Atoll.
22	8.15 A.M.		Left Rurick Pass, and coasted off Wotje Atoll.
	Noon.	54	Off Schischmarev Island, Wotje Atoll.
	1.40 P.M.		Arrived at Wotje Island Anchorage, Wotje Atoll.
23	8.00 A.M.		Left Wotje Island Anchorage, Wotje Atoll.
	Noon.	26	9° 12′ N. 170° 13′ E.
24	Noon.	147	Off N. W. Point Arhno Atoll.
	Noon–1.45 P.M.		Coasting off Arhno Atoll.
	3.15 P.M.	19	Arrived at Arhno Lagoon.
28	8.30 A.M.		Left Arhno Lagoon.
	10.00 A.M. until 2.40 P.M.		Coasting off Arhno Atoll.
	Noon.	24	Off N. W. Point Arhno Atoll.
29	Noon.	158	Off S. E. Pass, Jaluit Atoll.
	1.27 P.M.	8	Arrived at Jaluit, Jaluit Atoll.
	MARSHALL ISLANDS, THROUGH CAROLINE ISLANDS TO GUAM, LADRONE ISLANDS, AND TO YOKOHAMA, JAPAN.		
Feb. 5	10.25 A.M.		Left Jaluit, Jaluit Atoll.
	Noon.	15	Off S. W. Pass Jaluit Atoll.
6	Noon.	195	5° 27′ N. 166° 30′ E.

Date 1900.	Time.	Distance in Miles Noon to Noon	Position.
Feb. 7	Noon.	184	5° 31′ 163° 26′
	6.30 P.M.	37	Arrived at Port Lottin, Kusaie Island, Caroline Islands.
9	1.25 P.M.		Left Port Lottin, Kusaie Island.
10	Noon.	147	6° 09′ N. 160° 50′ E.
	1.00–2.00 P.M.		Lying to off Pingelap Islands.
11	Noon.	155	6° 47′ N. 158° 14′ E.
	3.45 P.M.	25	Arrived at Kiti Harbor, Ponapi Island.
12	12.50.		Left Kiti Harbor, Ponapi Island.
13	Noon.	138	6° 53′ N. 156° 00′ E.
14	Noon.	159	6° 55′ 153° 26′
	6.50 P.M.–Midnight.		Lying to off Namo Island.
	Noon.	110	7° 06′ N. 151° 46′ E.
	4.55 P.M.	28	Arrived at Uola Island, Truk Group.
17	2.00		Left Uola Island, Truk Group.
18	9.10 A.M. until 2.25 P.M.		Coasting along Namonuito Group.
	Noon.	131	Off Onoupe Island, Namonuito Group.
19	Noon.	151	10° 34′ N. 148° 25′ E.
20	Noon.	176	12° 23′ 146° 26′
21	Noon.	135	Off Agaña, Guam.
	1.55 P.M.	10	Arrived at San Luis d'Apra, Guam.
25	8.25 A.M.		Left San Luis d'Apra, Guam.
	Noon.	25	13° 48′ N. 144° 54′ E.
	2.30–3.09 P.M.		Coasting off Rota Island.
26	Noon.	204	17° 07′ N. 141° 45′ E.
27	Noon.	220	20° 46′ 144° 24′
28	Noon.	210	24° 15′ 141° 02′
March 1	Noon.	197	27° 28′ 143° 40′
2	Noon.	212	30° 53′ 142° 47′
3	Noon.	185	33° 28′ 140° 41′
4	10.00 A.M.	140	Arrived at Yokohama, Japan.
		15,122	

LIST OF THE STATIONS

OCCUPIED BY THE U. S. F. C. S. "ALBATROSS," DURING HER CRUISE IN THE TROPICAL PACIFIC,

AUGUST, 1899–MARCH, 1900.

SAN FRANCISCO, CALIFORNIA, TO NUKUHIVA, MARQUESAS ISLANDS.

Serial Number	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude North.	Longitude West.	Surface.	Bottom.			
		° ′	° ′	°	°			
1	Aug. 26	31 10	125 00	63	. .	1955	. . . . .	Lost thermometer and detacher; 320 miles from Point Conception.
2	Aug. 27	28 23	126 57	66	34.6	2368	Red clay. Light brown ooze.	450 miles from Guadalupe Island, 500 miles from Point Conception. Large haul of manganese nodules, sharks' teeth, and cetacean bones.
3	Aug. 28	26 18	128 54	68	. .	. .	. . . . .	. . . . .
4	Aug. 29	24 45	130 16	69	34.6	2628	Light brown ooze, same as at St. 2. Red clay.	. . . . .
5	Aug. 30	22 42	131 54	70	34.6	2740	Light brown ooze, same as at St. 2. Red clay.	Too rough to trawl; distant from Guadalupe Island 800 miles, from Point Conception 960 miles.
6	Aug. 31	20 26	133 28	75	. .	2810	Dark brown mud ooze. Red clay.	Distant from Guadalupe Island 960 miles, from Sebastian Viscaino 1060 miles.
7	Sept. 1	18 19	134 57	76	. .	2881	Red clay. Dark brown ooze. Very sticky.	. . . . .
8	Sept. 2	17 13	136 09	78	. .	2766	. . . . .	. . . . .
9	" "	16 52	136 12	76	. .	3003	. . . . .	. . . . .
10	" "	16 38	136 14	78	. .	3088	. . . . .	Deepest part of Moser Basin.
11	Sept. 3	14 38	136 44	79	. .	2646	Red clay.	Passing out of deepest part of Moser Basin.
12	Sept. 4	12 07	137 18	81	. .	2883	Red clay, radiol.	. . . . .
13	Sept. 5	9 57	137 47	82	. .	2690	Red clay. Light brown ooze, coarse mineral particles Radiolarian ooze.	Large balls of manganese nodules, cetaccan bones, sharks' teeth.
14	Sept. 7	6 41	137 00	82	. .	2776	Gray ooze glob. Foram. no radiolarians. Not sticky.	. . . . .
15	Sept. 8	4 35	136 54	79	. .	2583	Fine gray ooze. Radiolarians.	. . . . .
16	Sept. 9	2 38	137 22	79	35.2	2440	Light yellow gray glob. ooze.	To Hawaiian Islands 1500 miles, to Marquesas 660 miles.
17	Sept. 10	0 50	137 54	79	. .	2163	Light yellow gray glob. ooze.	Sea too heavy to sound after this till Sept. 13.

Serial Number	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface.	Bottom.			
		° ′	° ′	°	°			
18	Sept. 13	6 25	138 59	80	35	2475	Light gray yellow ooze. Globig. ooze. Radiolarian.	About 175 miles to Marquesas. Stations 1–18 referred to H. O. Chart No. 527, corrected to April, 1897.
19	" "	7 58	139 09	79	. .	2287	Coarse glob. ooze.	Stations 19 to 29 referred to H. O. Chart No. 1797, edition of May, 1899.
20	Sept. 14	8 13	139 10	79	35.1	2267	Glob. ooze with volcanic particles.	. . . . .
21	" "	8 28	139 12	79	. .	2183	Glob. ooze. Many volcanic particles.	. . . . .
22	" "	8 31	139 26	79	. .	1939	Glob. ooze. Fine volcanic particles.	. . . . .
23	" "	8 33	139 36	80	35.5	1802	Gray ooze. Glob. and Radiol. and coarse volcanic particles.	Globigerinae still retaining their color. Developing the Marquesas Plateau.

MARQUESAS ISLANDS TO TAHITI, SOCIETY ISLANDS, VIA NORTHWESTERN PAUMOTUS.

Stations in Vicinity of the Marquesas Islands.

24	Sept. 14	8 41	139 46	80	. .	1040	Coarse glob. ooze. Volcanic particles.	15½ miles N. 43° W., same as below.
25	" "	8 48	139 48	80	38	830	Globig. and volcanic mud and fragments.	13 miles N. 73° W. of Haunanu Point, Ua Huka Island.
26	" "	8 52	139 52	80	. .	1173	Glob. ooze. Pteropods and volcanic particles.	17 miles west of Mt. Uranupe, Nukuhiva Island (Tai o haé).
27	Sept. 15	9 01	140 04	79	. .	687	Glob. ooze. Volcanic particles.	6 miles S. 20° E. of Anna Maria Bay.
28	Sept. 17	9 05	140 13	80	. .	1284	Rocky. Volcanic fragments.	About 18 miles S. 13° W. of Chichakoff Point.

Stations from the Marquesas to Rangiroa.

29	Sept. 17	9 16	140 25	80	34.9	1932	Light yellow gray glob. ooze. Coarse volcanic particles.	25 miles from Cape Chichakoff, Nukuhiva, 20 miles from Ua pu Island.
30	Sept. 18	10 29	141 52	81	35	2456	Light gray glob. Few Radiol. Volcanic particles.	Stations 30, 31 referred to H. O. Chart No. 824[a], Oct. 1888.
31	Sept. 19	12 20	144 15	80	35	2700	Red clay.	Deepest part of Channel separating the Marquesas from the Paumotus.
32	Sept. 20	13 37	145 42	80	35	2451	Red clay with Foram.	Stations 32–35 referred to H. O. Chart No. 77, corrected to 1899.
33	" "	14 10	146 10	81	35.1	2527	Red clay.	22 miles N. 28° E. of entrance to Ahii.
34	" "	14 26	146 25	81	. .	1208	Very light col. glob. ooze.	About 2½ miles northwest of entrance to Ahii.
35	Sept. 21	14 42	147 08	80	. .	1462	Fine coral sand glob.	Position according to H. O. Chart No. 77.

Serial Number.	Date. 1899.	Position. Latitude South.	Position. Longitude West.	Temperatures. Surface.	Temperatures. Bottom	Depth in Fathoms.	Nature of Bottom.	Remarks.
				RANGIROA TO TIKEHAU AND TO MATAHIVA.				
36	Sept. 21	° ′ 14 45	° ′ 147 38	° 80	° . .	706	Volcanic rock fragments.	Stations 32–35 referred to H. O. Chart No. 77, corrected to 1899. Distant 16 miles northeast of Avatoru Pass, Rangiroa, according to H. O. Chart No. 77. Stations 36 to 60 referred to H. O. Chart No. 85, corrected to 1891.
37	Sept. 24	. . .	. . . .	80	. .	112	Coral sand.	⅝ mile from Beacon at the entrance to Avatoru Pass. Stations 37 to 42. Running a line N., normal in continuation of Avatoru Pass.
38	" "	. . .	. . . .	80	. .	604	Broken shells and sea-urchins. Pteropods. Glob. Rad. Mineral particles.	1⅝ miles from Beacon, entrance to Avatoru Pass.
39	" "	. . .	. . . .	80	. .	645	Fine coral sand, glob. ooze. Broken shells Mineral particles.	Same line, 1 mile farther north.
40	" "	. . .	. . . .	80	. .	661	Coral sand. Glob Pteropods. A few Radiolarians.	Same line, 1 mile farther north.
41	" "	. . .	. . . .	81	. .	684	Coral sand. Glob. and volcanic particles.	2 miles farther north, same line.
42	" "	. . .	. . . .	81	. .	819	Coral sand. Glob. Volcanic particles.	2¼ miles farther north. Same line. About 8 miles north, off Avatoru entrance. St. 35 was about 25 miles at right angles to Rangiroa, and showed a depth of 1462 fathoms, the edge of plateau being between it and St. 36.
43	" "	15 13	147 53	82	. .	341	Coarse coral sand.	About ⅜ mile from Reef off south shore Rangiroa.
44	" "	. . .	. . . .	82	. .	391	Coarse coral sand.	1 mile from south shore, Rangiroa.
45	" "	. . .	. . . .	82	. .	521	Coarse coral sand, broken shells. Pteropods, glob. ooze.	1 mile from last station. Normal to coast.
46	" "	. . .	. . . .	80	. .	150	Pteropod ooze, coral sand, small manganese nodules, round grains of coral sand.	2 miles from last station. Positions of St. 43 to 60 approximate, referred to H. O. Chart No. 85, as corrected by "Albatross."
47	" "	. . .	. . . .	82	. .	761	Coral sand, volcanic or manganese particles. Glob.	3 miles from last station.
48	" "	. . .	. . . .	80	. .	897	Glob. Foram. Pteropods. Manganese or lava particles.	5 miles from last station, 11 m. S. 15° W. of Station 44.
49	" "	15 25	148 08	80	. .	1123	Coral sand, manganese (?) particles. Globigerinae.	. . . . .
50	Sept. 25	15 25.5	148 24.4	80	. .	1486	Glob. ooze. Manganese particles (?).	. . . . .
51	" "	15 02	148 24	80	. .	488	Coarse coral sand. Glob.	1 mile from shore of Tikehau, going towards Matahiva.

Serial Number.	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface.	Bottom.			
		° ′	° ′	°	°			
52	Sept. 25	15 01.4	148 25	80	. .	670	Coarse coral sand, broken shells and glob.	1 mile from last position. This sounding is deeper than one off Rangiroa at same distance from shore.
53	" "	. . .	. . . .	81	. .	782	Pteropod ooze. Glob. Manganese particles (?).	2 miles from last position.
54	" "	. . .	. . . .	81	. .	850	Pteropod ooze, few globig.	3 miles from last position. Same normal.
55	" "	. . .	. . . .	81	. .	844	Globig. ooze, small manganese nodules.	5 miles from last position. Same normal.
56	" "	14 56	148 44	81	. .	711	Pteropod ooze, fine coral sand. Globig. ooze. Small manganese nodules.	8 miles from last position. Same normal. Changed course to go round the north side of the Island of Matahiva.
57	" "	. . .	. . . .	80	. .	486	Coarse coral sand. Volcanic (?) particles. Manganese (?)	3 miles from last station, going north.
58	" "	. . .	. . . .	80	. .	624	Coarse coral sand.	2½ miles off west shore of Matahiva.
59	" "	. . .	. . . .	80	. .	860	Glob. ooze. Coral sand. Volcanic (?) particles.	1 miles off southwest shore of Matahiva.
60	" "	. . .	. . . .	80	. .	1257	Coarse coral sand. Globigerinae. Volcanic (?) particles.	Off south shore of Matahiva, about 7½ miles farther off shore than St. 59.
		Matahiva to Makatea and to Papeete, Tahiti Island.						
		° ′	° ′	°	°			
61	Sept. 25	15 16	148 46	79	. .	1762	Light gray glob. ooze.	St. 61 to 180 referred to H. O Chart No. 77, corrected to 1899.
62	Sept. 26	15 33	148 45	80	. .	2267	Glob. ooze and mud (volcanic?), allied to red clay.	On way to Makatea.
63	" "	15 42	148 44	80	. .	2247	Globigerinae and mud allied to red clay.	. . . . .
64	" "	15 51	148 15	80	. .	581	Coarse coral sand.	About 1 3/16 miles off the bluff on west side of central part of Makatea.
65	" "	15 57.3	148 18.8	80	. .	1363	Coarse coral sand. Small manganese nodules.	5 miles south of Makatea. This is the first of a line of soundings from Makatea to Tahiti. St. 65 to 72
66	" "	16 10	148 26	80	. .	2238	Volcanic mud. Manganese nodules. Globigerinae.	. . . . .
67	Sept. 27	16 22	148 40	80	. .	2363	Volcanic mud. Globigerinae.	. . . . .
68	" "	16 57	148 58	79	. .	2224	Coarse volcanic mud Globigerinae.	. . . . .
69	" "	17 14	149 10	80	. .	1930	. . . . .	20 miles from last station.
70	" "	17 21	149 15	80	. .	1585	Fine volcanic mud, yellow brown.	10 miles from last station.
71	" "	17 25.3	149 26	81	. .	775	Coarse volcanic mud. Manganese(?) nodule.	1½ miles N. 32° E. from Point Venus. 6 miles from last station.
72	Sept. 27	17 26.5	149 32.4	79	. .	867	Fine volcanic sand. Coral sand. Globigerinae.	1 miles N. 54° W. from Point Venus. 6 miles from last station.

THROUGH THE PAUMOTU ARCHIPELAGO.

Tahiti to Makatea via Tetiaroa.

Serial Number.	Date. 1899.	Position. Latitude South.	Position. Longitude West.	Temperatures. Surface.	Temperatures. Bottom.	Depth in Fathoms.	Nature of Bottom.	Remarks.
		° ′	° ′	°	°			
73	Oct. 5	17 27	149 32	79	. .	807	Fine volcanic sand. Pteropods.	3.8 miles N. 55° W. from Point Venus.
74	" "	17 28.4	149 34	79	. .	. . .	. . . . .	4.8 miles N. 82° W. from Point Venus. Drifted, while trawling, from St. 73 to 74.
75	" "	16 57	147 29	80	. .	1592	Volcanic mud mixed with globigerinae.	Tetiaroa distant 6 miles.

Makatea to Apataki via Niau.

		° ′	° ′	°	°			
76	Oct. 6	15 56.2	147 40	80	35	2269	Light brown volcanic mud and glob. ooze.	St. 76 to 81. Line from Makatea to Niau.
77	Oct. 7	16 03	147 11	79	36	1322	Glob. ooze. Volcanic particles.	. . . . .
78	" "	16 08	146 42	79	39	609	Glob. ooze.	About 10 miles off Niau.
79	" "	16 10	146 23	79	. .	252	Coral sand and globigerinae.	About ¾ mile off shore, Niau.
80	" "	16 11.5	146 25	80	. .	491	Pteropod ooze. Globigerinae.	1.75 miles off shore, southwest of village, Niau.
81	" "	15 54.5	146 20	80	. .	677	Coral sand. Glob. ooze.	14 miles from Niau, bearing S. 3° E. About 10 miles from Kaukura N. 14° W.
82	" "	15 42	146 20	80	. .	675	Pteropod ooze.	In triangle Apataki, distant N. 6 miles; Kaukura, S. 60° W., distant 9 miles; Toao, N. 81°, distant about 12 miles
83	" "	15 34	146 26	80	. .	333	. . . . .	½ mile S. 45° W. from Pakaka entrance to Apataki.
84	Oct. 8	15 35.8	146 27.5	79	39.4	613	Coral sand. Glob. Broken shells. Pteropods.	Off Apataki Entrance, about 2 miles S. 50° W.
85	" "	15 34.3	146 28	80	. .	520	Coral sand.	About 1 mile S. 55° W. of Pakaka Entrance.

Apataki to Tikei.

		′	′					
86	Oct. 8	15 18.3	146 23	80	38.8	654	Coarse coral sand.	First of a line to Tikei. About 1 mile from northwest corner of Apataki.
87	" "	15 15	146 07	80	. .	1364	Glob. ooze. Few volcanic particles.	About 7 miles N. 45° E. off northeast point of Apataki.
88	Oct. 9	14 57	144 34	80	. .	360	Coarse coral sand. Pteropod shells.	½ mile off west shore of Tikei where landed.

Ngaruae Pass, Fakarava to Takume via Anaa and Tahanea.

		′	° ′	°				
89	Oct. 14	16 03.5	145 43	80	. .	599	Coarse coral sand.	About 1 mile N. 28° W. of north entrance to Fakarava. First of line of soundings in continuation of Ngaruae Pass.

Serial Number	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface.	Bottom.			
		′	′					
90	Oct. 14	16 02	145 43.5	80	. .	666	Coarse coral sand. Pteropods.	About 3 miles farther north than last station. $3\frac{1}{2}$ miles N. 35° W. from Ngaruae Pass.
91	" "	16 38	145 31	80	. .	602	Coarse coral sand. Pteropod ooze.	About 2 miles due S.W. from southwest Point of Fakarava.
92	" "	16 44	145 35	80	. .	839	Coral coated with manganese.	$\frac{5}{6}$ mile farther than Station 91.
93	" "	16 51	145 42	80	35.7	1300	Glob. ooze.	10 miles farther than 92. Line to Anaa at first 40 miles to S.W., then 30 miles to north side of Anaa.
94	" "	16 57	145 49	79	. .	1531	Fine volcanic mud and globigerinae.	10 miles from Station 93.
95	Oct. 15	17 09	146 00	78	36.10	1079	Glob. ooze.	Changed course toward Anaa at this station.
96	" "	17 14.5	145 49	77	39.7	527	Coral frgts. covered with manganese.	. . . . .
97	" "	17 17	145 45.5	79	. .	804	Globig. ooze and many very small manganese nodules.	6 miles from Station 96.
98	" "	17 21	145 41	79	. .	642	Pteropod ooze. Manganese nodules on coral sand.	Off Anaa, 6 miles from Station 97.
99	" "	17 22	145 37	79	39	568	Manganese nodules. Coarse coral sand.	About $1\frac{3}{10}$ miles off northwest face of Anaa.
100	" "	17 20	145 31	80	. .	225	Coral sand.	About $\frac{1}{4}$ mile to edge of reef off village at entrance to lagoon of Anaa.
101	" "	17 16	145 27	80	36	1110	Pteropod ooze. Fine coral sand. Manganese nodules.	About 5 miles N. 50° E. off Anaa Entrance. This is first of a line of soundings across to Tahanea. St. 101 to 106.
102	" "	17 10	145 19	82	36	1679	Light yellowish brown globig. ooze.	. . . . .
103	" "	17 03	145 08.5	82	35.1	1733	White glob. ooze.	15 miles from Station 102.
104	" "	16 55	145 03	81	. .	966	White glob. ooze. Few manganese nod. grains.	About 10 miles from Station 103, 4 miles W.S.W. from southwest point of Tahanea.
105	" "	16 53	145 00	80	38.6	654	Very small manganese nodules. Coral sand.	About 2 miles W. of southwest point of Tahanea.
106	Oct. 16	16 55	144 56	80	. .	269	Coarse coral sand.	About $\frac{1}{2}$ mile off south shore of Tahanea and about 3 miles S. 45° W. of southwest point of Tahanea.
107	" "	16 24	143 59	80	. .	467	White coral sand.	1 mile N.W. of northwest Pass to Makemo on angular line to Raroia.
108	" "	16 20	143 55	80	. .	856	Pteropod ooze. Fine coral sand. Light yellow gray glob. Few volcanic particles (?).	4 miles N. of northwest end of Makemo.
109	" "	16 13	143 48	80	. .	987	Pteropod ooze. Glob. Volcanic particles(?).	10 miles north of Station 108.
110	" "	16 03	143 32.5	80	36.3	1084	Light yellow gray glob. ooze.	15 miles north of Station 109.
111	Oct. 17	15 53	143 26	80	35	1805	Light yellow gray glob. ooze.	At next station on line to Raroia changed direction at Station 111.
112	" "	15 54	143 06	80	35.4	1568	Glob. ooze. Light yellow. Manganese.	20 miles from St. 111.

Serial Number.	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface.	Bottom.			
		° ′	° ′	°	°			
113	Oct. 17	15 55	142 39	80	. .	1503	Glob. ooze. Light yellow. Manganese.	20 miles from St. 112.
114	" "	15 56	142 29	80	35.7	1385	Glob. ooze. Few manganese particles.	This is about 5 miles from centre of west coast of Raroia.
115	" "	15 56.3	142 29	81	40.2	508	Coarse coral sand. Pteropod ooze.	About ½ mile from the shore at northwest point of Raroia.
116	Oct. 18	15 53	142 14	79	38.7	572	Coarse coral sand.	About 1½ miles off southwest point of Takume.
117	" "	15 54	142 16	79	38	563	Coral sand incrusted with manganese.	Half way between Takume and Raroia.
		Takume to Makemo via Raroia and Taenga.						
		° ′	° ′	°	°			
118	Oct. 18	16 12	142 31	80	38.2	630	Coarse coral sand. Pteropod ooze and manganese particles	About 1 mile off southwest point of Raroia.
119	" "	16 14	142 50	80	35.5	1516	Glob. ooze. Manganese particles.	Half way between Raroia and Taenga.
120	" "	16 21	143 14	80	36.5	928	Glob. and pteropod ooze.	About 3 miles S. 67° W., off southwest face of Taenga.
121	Oct. 19	16 25	143 33	79	36.1	1108	Glob. ooze, a few pteropods, and manganese particles.	About half way to Taenga.
		Makemo to Hikueru via Tekokoto.						
		° ′	° ′	°	°			
122	Oct. 20	16 29	143 41	79	39.7	540	Coral sand. Pteropod ooze.	About 1 mile off north shore of Makemo.
123	Oct. 25	16 35	143 31	80	39	603	Coarse coral sand.	About 1 mile off entrance to Makemo.
124	" "	16 42	143 10	79	. .	1221	Glob. ooze. Manganese.	11 miles E. by S. off east point of Makemo, on line to Tekokoto.
125	Oct. 26	16 51	142 57	79	36	1135	Glob. ooze.	Half way between Nihiru and Marutea.
126	" "	17 07	142 49	79	35.9	1235	Glob. manganese.	. . . . .
127	" "	17 20	142 35	79	. .	617	Coral sand.	About 1 mile west from Tekokoto.
128	" "	17 28	142 38	80	36.6	1009	Pteropods and glob. ooze.	Half way to Hikueru from Tekokoto. 6 miles north of centre of Hikueru atoll.
129	Oct. 27	17 35	142 42	80	43.8	348	Coral sand and broken shells.	⅓ of a mile W. of northwest point of Hikueru.
130	" "	17 35	142 44	80	37.8	798	Coral sand. Pteropod ooze.	1⅓ mile west of last station. Same normal.
		Hikueru to Hao via Marokau and Ravahere.						
		° ′	° ′	°	°			
131	Oct. 28	17 47	142 29	79	35.7	1372	Glob. ooze.	Half way between Hikueru and Marokau.
132	" "	18 00	142 29	77	35.6	1620	Glob. ooze.	8 miles west of Marokau.
133	" "	18 05	142 23	78	35.5	742	Pteropod ooze.	About 2 miles off north end of Marokau.
134	" "	18 06	142 24	79	37.6	807	Fine coral sand and manganese nodules.	3 miles off northwest point of Marokau.

Serial Number.	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface.	Bottom.			
		′	° ′	°	°			
135	Oct. 28	. . .	. . . .	79	48.1	278	Fine coral sand. Manganese nodules. Globigerinae.	Half way between heads of pass between Marokau and Ravahere.
136	" "	18 08	141 49	79	35.2	2187	Fine volcanic mud. Globigerinae.	About 20 miles from last station.
137	Oct. 29	18 07	141 26	78	. .	1713	Globigerinae and few manganese particles.	About 20 miles from last station. Depth indicates rise or spur.
138	" "	18 05	141 03	79	42	425	Coarse coral sand.	About ½ mile off northwest point of Hao.
139	" "	18 08	141 04	79	37.6	812	Coral sand.	2 miles W. of northwest face of Hao.
		Hao to Aki Aki.						
		° ′	° ′	°	°			
140	Oct. 29	18 27	140 21	77	35.1	2042	Light brown volcanic mud with globigerinae.	20 miles from Hao. Stations 140–144, line Hao to Aki Aki.
141	Oct. 30	18 29	139 53	78	35	1490	Globigerinae. Large species. Few manganese particles.	Ridge 25 miles from last station.
142	" "	18 30	139 30	78	35.1	2103	Fine light brown volcanic mud, with globigerinae.	20 miles from last station.
143	" "	18 34	139 19	78	35.6	1364	Manganese particles. Globigerinae.	5 miles from Aki Aki. 10 miles from last station.
144	" "	18 30	139 15	. .	. .	377	Coarse coral sand, broken shells.	1 mile off southwest end of Aki Aki.
		Aki Aki to Pinaki via Nukutavake.						
		° ′	° ′	°	°			
145	Oct. 30	18 36	139 14	78	35	1725	Coarse coral sand.	5 miles south of Aki Aki. Stations 145–148, line Aki Aki to Nukutavake.
146	Oct. 31	18 56	139 05	78	35.1	2343	Red clay. Few globigerinae.	20 miles from last station.
147	" "	19 17	138 54	78	35	1688	Manganese nodules. Globigerinae.	6 miles W. of north end of Nukutavake.
148	" "	19 16	139 49	78	38.9	636	Coral sand.	1 mile off north point of Nukutavake.
149	" "	19 23.5	138 46	78	37	860	Nothing in cup. Hard bottom.	3.5 miles northwest of Pinaki, between it and Nukutavake.
		Pinaki to Nukutipipi.						
		° ′	° ′	°	°			
150	Oct. 31	19 27.5	138 44	79	41	486	Coarse coral sand. Pteropod ooze.	1 mile west of Pinaki. St. 150 to 158, line Pinaki to Nukutipipi.
151	" "	19 27	138 47	79	35	1907	Glob. ooze. Volcanic mud.	5 miles W. S.W. from Pinaki.
152	" "	19 35	139 13	78	35.1	2335	Red clay. Few globigerinae.	25 miles from last station.
153	Nov. 1	19 45.5	139 54	77	35.4	1494	Globigerinae, small nodules and particles of manganese.	40 miles from last station. This ridge may be a spur of Ahunui, or an independent ridge.

Serial Number.	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West.	Surface	Bottom.			
		° ′	° ′	°	°			
154	Nov. 1	19 52	140 16	77	35	2284	Red clay.	20 miles from last station.
155	" "	20 07	141 00	78	35	2391	Manganese particles. Red clay.	40 miles from last station.
156	Nov. 2	20 31	142 00	77	35	2467	Red clay. No organic remains.	60 miles from last station.
157	" "	20 46.5	142 51	78	35	2315	Red clay and number of globigerinae.	About 5 miles southeast from Nukutipipi.
158	" "	20 43	143 0.5	77	39	649	Coral sand. Broken shells. Pteropods.	About 1 mile southeast of Nukutipipi.
		Nukutipipi to Hereheretue via Anu Anurunga and Anu Anuraro.						
159	Nov. 2	20 42	143 03	77	. .	736	Coral sand, pteropods, broken shells, manganese particles	1 mile W.N.W. on course of Nukutipipi to Anu Anurunga.
160	" "	20 40	143 09	78	35.5	1609	Coral sand. Few globigerinae. Manganese particles.	Half way to Anu Anurunga. Sounding indicates a low ridge connecting the islands of the Gloucester group.
161	" "	20 37	143 15	78	39	574	Pteropod ooze. Coarse coral sand and manganese particles.	1 mile off east side of Anu Anurunga.
162	" "	20 37	143 18	78	38.5	659	Coral sand, pteropods, and broken shells.	One mile northwest of Anu Anurunga, on line to Anu Anuraro.
163	" "	20 34	143 23	78	35.2	1890	Light gray glob. ooze. Small and large globigerinae.	Half way to Anu Anuraro from Anu Anurunga.
164	" "	20 29	143 29	78	40.7	438	Coral sand.	$\frac{3}{4}$ of mile from shore off southeast side of Anu Anuraro.
165	" "	20 27	143 32	77	42.5	406	Coral sand. Pteropods. Small manganese nodules.	$\frac{1}{2}$ mile northwest of Anu Anuraro. St. 165 to 168, line Anu Anuraro to Hereheretue.
166	" "	20 15	144 00	77	34.8	2265	Red clay. Globigerinae. Manganese.	26 miles from last station.
167	Nov. 3	20 02	144 28	78	34.9	2524	Very soft red clay. Few globigerinae.	3 miles from last station. Continue to find manganese particles and small nodules at nearly every sounding.
168	" "	19 54	144 48	77	35	1719	Globigerina ooze.	6 miles from last station. East of Hereheretue.
169	" "	19 54	144 53	78	39.5	594	Coarse coral sand.	1 mile off the east coast of Hereheretue.
		Hereheretue to Tahiti via Mehetia.						
170	Nov. 3	19 54	144 59	78	62.1	189	Coral sand. Manganese particles.	$\frac{3}{10}$ mile from edge of reef on west side of Hereheretue. St. 170 to 176, line Hereheretue to Mehetia.
171	" "	19 50	145 03	78	35.3	1688	Light gray glob. ooze. Manganese particles.	5.3 miles northwest of Hereheretue.
172	" "	19 22	145 47	77	35	2322	Red clay with globigerinae.	50 miles from last station.

Serial Number.	Date. 1899.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude South.	Longitude West	Surface.	Bottom.			
		° ′	° ′	°	°			
173	Nov. 4	18 55	146 32	78	34.8	2440	Red clay. Large haul of trawl of manganese nodules.	50 miles from last, half way to Mehetia from Hereheretue.
174	" "	18 28	147 11	79	35	2087	Two spherical manganese nodules, about 15 mm. in diameter jammed cup open.	
175	Nov. 5	18 03	147 48	78	34.8	2129	Coarse volcanic mud.	14 miles southeast of Mehetia.
176	" "	17 54	148 00	80	38.1	832	Volcanic mud and coral sand.	1¾ miles off southeast face of Mehetia.
177	" "	17 51	148 03	80	69	142	Volcanic rock and coral sand.	⅛ mile off north shore of Mehetia. St. 177–179 Mehetia to Tahiti.
178	" "	17 46	148 23	81	34.9	2111	Volcanic sand.	23 miles from Mehetia.
179	" "	17 35	148 48	80	35	1755	Volcanic sand.	30 miles from Tahiti.

SOCIETY ISLANDS TO TONGATABU, TONGA ARCHIPELAGO VIA LEEWARD SOCIETY ISLANDS, THE COOK GROUP, AND NIUE ISLAND.

From Tahiti to Leeward Society Islands.

		° ′	° ′	°	°			
180	Nov. 15	17 30	149 41	79	36.7	981	Volcanic sand. Pteropod ooze.	About half way to Murea from Papeete. 5 miles from the northeast point of Murea.

From Aitutaki to Niue.

		° ′	° ′	°	°			
181	Nov. 22	18 54	162 31	79	34.7	2498	No sample.	Sts. 181–184 referred to H. O. Chart No. 825*, corrected to April, 1896.
182	Nov. 23	18 59	164 47	82	33.4	2882	Red clay. Glob.	. . . . .
183	Nov. 24	19 04	167 41	80	33.9	2472	Red clay. Radiol.	. . . . .

From Niue to Eua (Tonga).

		° ′	° ′	°	°			
184	Nov. 26	20 15	172 00	80	34	3141	Red clay. Radiol.	. . . . .
185	Nov. 27	21 18	173 31	. .	. .	4173	Light brown volcanic mud. Radiol.	Near 4762 fms. hole, siliceous sponges in trawl. Deepest haul of trawl yet made. Lost thermo.
186	" "	21 18	173 51	77	34.15	4540	Light brown volcanic mud. Radiol.	. . . . .

VAVAU TO FIJI.

		° ′	° ′	°	°			
187	Dec. 4	18 47	174 15	79	. .	682	Pteropods and very peculiar coral sand, resembles volcanic sand, with white crystals of calcite, gray brown.	Between Vavau and Lette. Sts. 185 to 188 referred to B. A. Chart No. 2421, corrected to August, 1899.
188	Dec. 6	18 43	175 28	79	36.2	1381	Volcanic mud, glob.	Beyond Lette to westward.

Serial Number.	Date. 1899–1900.	Position. Latitude South.	Position. Longitude West.	Temperatures. Surface.	Temperatures. Bottom.	Depth in Fathoms.	Nature of Bottom.	Remarks.
			IN FIJI ARCHIPELAGO.					
189	Dec. 7	° ′ 18 50	° ′ 178 28	° 79	° 42.9	453	Fine coral sand. Pteropod ooze. Few glob.	About in centre of passage between Yangasá–Mothe. Southern extension of eastern Fiji plateau.
190	" "	18 54	178 35	79	47	324	Coral sand. Colored in part by manganese.	Between Namuka and Yangasá. Sts. 189–193 referred to B. A. Chart No. 2691, corrected to Dec., 1897.
191	" "	18 56	178 43	79	39.3	600	Pteropod ooze. Fragments of pumice. Fine coral sand, glob.	6 miles S. 23° W. from west end of Namuka. Between Namuka and Marambo.
192	" "	18 56	178 50	79	42 4	450	Coral sand. Pteropods. Manganese, glob.	2.7 miles N. 19° W. from Marambo. In centre of triangle Marambo, Kambara, Wangava, about 5 miles distant.
193	Dec. 9	18 56.5	179 16	80	37	990	Very fine light yellow brown coral ooze.	About 15 miles west of Kambara, on way to Totoya.
			FIJI THROUGH ELLICE AND GILBERT ISLANDS TO JALUIT MARSHALL ARCHIPELAGO.					
194	Dec. 21	° ′ 12 43	° ′ 179 50 Longitude East.	° 85	° 35.6	1445	Light yellow brown glob. ooze.	H. O. Chart No. 825*, cor. April, 1895.
195	Dec. 22	10 47	179 30	. .	. .	245	Coral sand, rocky.	Tanner machine. ½ mile south, off Nurakita. B. A. Chart No. 1830, corr. March, 1898.
196	1900. Jan. 1	0 18	173 54	. .	. .	170	Hard bottom.	¾ mile south of village off south side of Apamama. Sts. 196–207 H. O. Chart No. 119, corr. May, 1899.
197	Jan. 2	Latitude North. 0 30	173 35	83	35	2221	Light yellow gray glob ooze. Struck globigerinae of Equat Current (obtained before in Paumotus)	On way Apamama–Maiana. About 16 miles from northwest end of Apamama.
198	" "	0 46	173 09	84	35.6	1365	Yellow gray glob. ooze. Very coarse large species.	About 9 miles southeast of Maiana.
199	" "	1 12	173 05	84	43.5	413	Same coarse large glob. ooze as before	Halfway to Tarawa from Maiana. Unknown summit.
200	" "	1 20	173 03	. .	. .	95	Broken shells. Coral sand.	About ½ mile from centre of south shore of Tarawa. Tanner sounding machine.
201	" "	1 20	173 04	. .	. .	200	. . . . .	About 1 mile E. of last station, off south shore of Tarawa. Tanner sounding machine.
202	Jan. 3	1 17	173 09	84	35.3	1569	Coarse large globigerinae. Same as before.	About 5 miles S. 12° E. of southeast point of Tarawa. Shoal said to extend there. Evidently no plateau; may be a ridge, connecting the islands Maiana, Tarawa, and Apaiang.

Serial Number	Date. 1900.	Position. Latitude North.	Position. Longitude East.	Temperatures. Surface.	Temperatures. Bottom.	Depth in Fathoms.	Nature of Bottom.	Remarks.
		′	′					
203	Jan. 4	1 40.5	172 59.5	. .	. .	170	. . . . .	About 2 miles from southeast point of Apaiang, between Apaiang and north point of Tarawa. Tanner sounding machine.
204	Jan. 4	1 52	173 15	84	34.9	2156	Light gray glob. ooze. Small species.	15 miles from Apaiang, on way to southeast point of Maraki, about half way.
205	" "	2 04	173 16	86	. .	431	Coral sand and globigerinae.	About ½ mile off shore off west coast of Maraki, N.W.-by-W. from monument.
206	Jan. 5	2 27	173 09	80	34.8	2255	Glob. ooze.	About 26 miles N.W.-by-N. of Maraki.
207	" "	2 49	173 01	83	35.3	1461	Glob. ooze. Large species.	About 16 miles southeast from centre of south shore of Taritari.
							FROM TARITARI TO JALUIT.	
		° ′	° ′	°	°			
208	Jan. 7	3 57	172 00	83	34.7	2486	Light yellow glob. ooze, coarse and fine.	About 60 miles northwest from Taritari. St. 208–239 B. A. Chart No. 983, April, 1891.
209	Jan. 8	4 25	171 13	83	34.7	2505	Light gray glob. ooze, medium size.	About 130 miles northwest from Taritari, about half way to Jaluit.
210	" "	4 54	170 21	83	34.7	2444	Light gray glob. ooze, coarse and medium size.	About 60 miles southeast from Jaluit.
211	Jan. 9	5 20	169 43	83	34.8	2411	Light yellow drab glob. ooze.	About 30 miles from Jaluit.
212	" "	5 44	169 45	82	35	1937	Light gray glob. ooze.	About 5 miles S. ¼ W. from the south point of Jaluit.
							THROUGH THE MARSHALL ARCHIPELAGO.	
		° ′	° ′	°	°			
213	Jan. 14	6 34	169 13	83	35	2613	Glob. ooze.	About 30 miles northwest from Jaluit.
214	Jan. 15	7 00	169 01	82	35	2137	Coarse globigerinae.	. . . . .
215	" "	7 08	168 56	82	35.9	1283	Coarse globigerinae.	About 9 miles S. 30° E. of southeast point of Ailinglab Lab.
216	" "	7 29	168 32	82	36.5	1068	Coral sand.	6 miles northwest of west point Ailinglab Lab.
217	" "	7 37	168 27	82	37	906	Coarse globigerinae.	Half way to Namu.
218	" "	7 45	168 21	83	39.7	631	Coarse coral sand.	About 2 miles south of south point of Namu.
219	Jan. 15	8 02	167 43	82	35	2179	Glob. mud.	About 12 miles west of centre of Namu.
220	Jan. 16	8 38	167 37	82	35	1897	Glob. mud.	About 12 miles southwest of west point of Kwajalong Island.
221	Jan. 18	11 09	166 46	80	43.4	400	Coral sand.	½ mile south of Southeast pass of Rongelab.
222	" "	11 07.5	166 46	80	39	827	Coral sand.	1½ miles south of Southeast pass of Rongelab.
223	" "	10 49	167 15	80	35	2469	Glob. and light brown volcanic mud. Red clay (?).	About 35 miles southeast from Southeast pass of Rongelab.
224	Jan. 19	10 30	167 42	80	35	2586	Globigerinae and light brown volcanic mud. Red clay (?)	About 35 miles from last station, towards Likieb.

Serial Number.	Date 1899.	Position. Latitude North.	Position. Longitude East.	Temperatures. Surface.	Temperatures. Bottom.	Depth in Fathoms.	Nature of Bottom.	Remarks.
		° ′	° ′					
225	Jan. 19	10 15	168 06	81	34.9	2609	Globigerinae and light brown volcanic mud. Red clay (?)	About 35 miles from last station, on way to Likieb.
226	Jan. 20	9 55	168 56	80	34.9	2231	Glob. mud.	About 8 miles W. S.W. of Kapenor Island. West of north point of Likieb.
227	Jan. 21	9 18	169 14	81	42.6	468	Coarse coral sand.	½ mile south of South pass of Likieb.
228	" "	9 47	169 14	81	36.9	934	Coarse coral sand.	1¼ mile south of South pass of Likieb.
229	" "	9 10	169 32	81	35.5	1583	Globigerinae. Very fine species.	About half way Likieb to Wotje.
230	Jan. 23	9 19	170 10	81	41.7	482	Coral sand.	1 mile south of Schischmarev Pass.
231	" "	9 17	170 11	81	36.1	1187	Coarse coral sand. Trace of manganese.	2 miles south of last station.
232	" "	8 50	170 26	81	34.9	2221	Wh. and gray glob. ooze.	About 40 miles south of last station, half way between south end of Erikub and Maloelab.
233	Jan. 24	7 54	170 56	80	36.5	1009	Coarse globigerinae.	. . . . .
234	" "	7 21	171 35	81	36	1326	Coarse globigerinae.	About 7 miles N. 50° W. from northwest point of Arhno.
235	Jan. 28	6 57	171 34	82	36	1253	Cream colored coarse globigerinae.	About 6 miles southwest of south point of Arhno.
236	" "	6 34	170 59	81	34.9	2482	Globigerinae.	About 40 miles from last station.
237	" 29	6 11	170 25	81	34.7	2486	Fine glob. mud.	About 40 miles from last station. The same deep water we found on coming north from the Gilberts, and also all through the Marshalls and between the islands both of the Ralick and Ratack chain.

MARSHALL ISLANDS THROUGH THE CAROLINES TO GUAM, LADRONES ISLANDS, AND TO YOKOHAMA, JAPAN.

238	Feb. 5	5 48	169 01	82	35	2424	Glob. mud. Coarse diat. cysts.	30 miles west of Jaluit.

THROUGH THE CAROLINES.

239	Feb. 9	. . .	. . . .	82	43.5	371	Volcanic and coral sand.	¾ mile south of Port Lottin, Kusaie.
240	Feb. 13	6 49	156 36	82	34.9	2475	Glob. and light brown volcanic mud.	⅓ way Ponapi and Truk. Sts. 240–244 H. O. Chart No. 1754, 1898.
241	" "	6 51	154 39	81	35	2533	Glob. mud. Light brown fine volcanic mud.	⅔ way Ponapi — Truk.
242	Feb. 14	6 55	152 40	82	41.5	526	Coarse coral sand.	About ½ mile south of Nama.
243	Feb. 15	6 47	152 11	82	35	2162	Light gray glob mud and few volcanic particles.	About 17 miles southeast of South Island, Royalist Islands.
244	Feb. 17	8 06	151 08	81	35	2205	Glob. mud.	About half way between Truk and Namonuito.

Serial Number	Date. 1900.	Position.		Temperatures.		Depth in Fathoms.	Nature of Bottom.	Remarks.
		Latitude North.	Longitude East.	Surface.	Bottom.			
		NAMONUITO TO GUAM.						
		° ′	° ′	°	°			
245	Feb. 18	9 31	149 36	81	35	2735	Red clay.	50 miles northwest from Magur islet.
246	Feb. 19	10 34	148 25	81	35	2993	Red clay and small particles of manganese nodules.	100 miles further towards Guam. Sts. 245–249 H. O. Chart No. 529, corr. June, 1896.
247	Feb. 20	11 35	147 15	80	35	3213	Manganese nodules. Pumice. Red clay.	100 miles further, same course, towards Guam.
248	" "	12 51	145 46	81	35.8	4813	Manganese. Pumice. Volcanic particles. disks of diatoms(?).	Our deepest sounding. 100 miles further, same course, towards Guam. Thermometer could not have registered correctly.
249	Feb. 21	13 08	145 25	80	35	2337	Fine volcanic sand.	About 25 miles further, same course, distant 45 m. from north end of Guam.

NOTES ON THE DEEP-SEA HAULS OF THE TRAWL AND DREDGE MADE BY THE "ALBATROSS" AND THE "CHALLENGER" IN THE PACIFIC.

The "Challenger" made four hauls of the trawl or dredge from the Admiralty Islands to Japan, eight between Yokohama and the Hawaiian Islands, four between the Hawaiian Islands and Tahiti, and eleven between Tahiti and Valparaiso. The "Albatross" made thirteen hauls in the line San Francisco to Tahiti across the deep Moser Basin.

In other parts of the Pacific exclusive of the Southern Ocean we have only the deep-water trawling of the "Challenger" near Fiji and Tongatábu and thence to New Zealand and south from Valparaiso; exclusive of hauls made in the enclosed seas to the westward of Borneo and New Guinea, the number of hauls in the deep areas of the Pacific are few in number, and have thus far made us acquainted with a comparatively small number of deep-water types. The few hauls made by the "Albatross" in the insular area of the Pacific would seem to indicate that in the Paumotus, Society Islands, Tongas, Ellice, Gilbert, and Marshall Islands the fauna of these areas was extremely poor as compared with the wealth of animal life brought to light by the "Blake" in the West Indies and by the "Albatross" in the Panamic district near the Galapagos and off the coast of Central America. The only other hauls in the Pacific are the few made by the "Gazelle" near the Fiji in less than 800 fathoms, and the large collections made for many years by the "Albatross" along the shore of Oregon, Washington, and Alaska, the Aleutian Islands, and in the Bering Sea. It must be remembered, however, that these collections of the "Albatross" were all obtained at a comparatively short distance from the American continent, — the greatest number of deep-sea hauls made at a distance from a continental area being those of the "Albatross" Expedition of 1891 in the Panamic district, a number of which were from five to 700 miles from the continental slope of Central America.

It is interesting to compare the lines run across the Pacific by the "Challenger" with those explored by the "Albatross" in the present expedition. The line run by the "Albatross" from San Francisco to Tahiti starts in lat.

31° 10′ N., long. 125° W., and terminates at Tahiti off Pt. Venus about in lat. 17° 30′ S., and long., 149° 30′ W. That of the "Challenger" starting north of the Hawaiian Islands in lat. 38° 9′ N., and long. 156° 25′ W., and ending also at Tahiti, converges towards the line of the "Albatross," so that we have an excellent opportunity of comparing the collections of the "Challenger" in the central Pacific with those obtained by the "Albatross" from the great red-clay and manganese-nodule area of the Pacific Ocean to the eastward. An examination of the results as recorded by Sir John Murray,[1] and those which I here give from the trawling of the "Albatross" show plainly that at great depths and far from continental areas or insular plateaux the bottom fauna of the great depths is comparatively poor except when the trawling is made in the line of the great equatorial currents, where the bottom fauna receives a larger amount of food, derived from the dead remains of the pelagic fauna falling to the bottom.

A similar increase in the number of animals brought up in the trawl can also be noted in the hauls made by the "Challenger" on the line east of Japan, while practically in the track of the great Japanese current sweeping to the eastward. In marked contrasts to this line and to the results obtained in the track of the equatorial current by the "Albatross" are the scanty hauls obtained by the "Challenger" from the Admiralty Islands north to Japan.

The line of dredgings made from Tahiti to Valparaiso is also relatively richer than the two principal lines across the deepest parts of the central Pacific explored by the "Challenger" and "Albatross." That is in part due to the nature of the bottom, which is often made up of Globigerina ooze, and also undoubtedly to the fact that the eastern extension of the "Challenger" line from Tahiti was run in the northern extension of the basin of the Southern Ocean, which, as is well known, has supplied a far richer deep-water bottom fauna than that found in the intertropical areas of the Pacific.

To facilitate the comparison between the results obtained in the Pacific by the "Challenger" and those of the "Albatross" during her trip to the

[1] In the General Summary of the "Challenger" results, and in the Deep Sea Deposits ("Challenger" Expedition) by Murray and Renard.

tropical Pacific, I have prepared an abstract of the results of the "Challenger" from trawling and dredging,[1] as well as a succinct account of the surface tows and of the bottom deposits compiled from the published records of the "Challenger." The same has been done for the results of the "Albatross," which have been treated in the same way and discussed with reference to the Pacific area covered by us to the eastward and northward of the "Challenger" lines, and to the westward of the Society Islands as far as Fiji, and from there to Guam via the Ellice, Gilbert, Marshall, and Caroline Islands. From Guam, as our line to Yokohama practically duplicated that of the "Challenger" we merely made a passage from the Ladrones to Japan.

The following are the results of the trawling and dredging of the "Challenger" in the Pacific, from the Admiralty Islands to Yokohama, thence to the Hawaiian Islands, to Tahiti and Valparaiso.

Leaving out of consideration Station 220, not more than eighty miles from the Admiralty Islands, where a good haul of the trawl was made in 1100 fathoms, we have Stations 221 and 222, where no haul was made; we then come to Station 223, lat. 5° 31′ N., long. 145° 13′ E., where a haul of the trawl was made in 2325 fathoms, but which contained only a young Hyocrinus, a small siliceous sponge attached to a piece of pumice, and a Penæid and a couple of Gonostoma, neither of which probably came from the bottom. This station was 464 miles from Guam, and some of the Carolines were not more than 90 miles distant. At the next station, 224, lat. 7° 45′ N., long. 144° 20′ E., in 1850 fathoms, the nearest Caroline being 52 miles and Guam 330 miles, the trawl contained only a deep-sea coral, one species of starfish, and two Ophiurans. At the deepest station, 225, lat. 11° 24′ N., long. 143° 16′ E., occupied by the "Challenger" in 4475 fathoms, about 140 miles southwest of Guam, only samples of the bottom were brought up while sounding. At the next station, 226, lat. 14° 44′ N., long. 142° 13′ E., in 2300 fathoms, about 150 miles northwest from Guam, the trawl brought up fragments of Freyella, and one

[1] General Summary of the scientific observations and results at each of the "Challenger" observing stations, by John Murray.

specimen of Gonostoma. The trawl was again used at Station 230, lat. 26° 29′ N., long. 137° 57′ E., in 2425 fathoms, about 250 miles west of the Bonin Islands, 510 miles from the Liu Kiu Islands, and about 480 miles from the nearest point of the coast of Japan. It was only when off Japan in 345 fathoms, near the noted Hyalonema ground, and other stations near the coast (Stations 232–233, 235–237), that rich hauls of the trawl were again made.

On the line east of Japan, at a distance of about 975 miles from the coast, Honolulu being distant 2484 miles, a good haul of the trawl was made in 2300 fathoms, Station 241, lat. 35° 41′ N., long. 157° 42′ E. An excellent haul was also made at Station 244, lat. 35° 22′ N., long. 169° 53′ E., in 2900 fathoms, Honolulu distant 1891 miles, and the nearest of the Kurile and Aleutian Islands about 1250 miles. A good haul was obtained at Station 246, lat. 36° 10′ N., long. 178° E., in 2500 fathoms, about 120 miles east of Station 244, while at Station 248, lat. 37° 41′ N., long. 177° 04′ W., in 2900 fathoms, comparatively little was obtained: two siliceous sponges, a specimen of Monocaulus and a Tunicate, with fragments of a Holothurian and an Echinid. A still poorer haul was made in 2740 fathoms at Station 252, lat. 37° 52′ N., long. 160° 17′ W., Honolulu distant 1002 miles.

At Station 253, lat. 38° 09′ N., long. 156° 25′ W., 3125 fathoms, a few Annelids and Polyzoa were collected. Nothing came up except a manganese nodule from the next station in 3025 fathoms, Honolulu distant 852 miles. When 568 miles from Honolulu, in 2950 fathoms, Station 256, lat. 30° 22′ N., long. 154° 56′ W., a Leda and a deep-sea sponge came up with manganese nodules. The rich hauls of two of the stations, 244, 246, in deep water at a great distance from land, about 1200 miles from the nearest land, but in the extension of the Japanese current, are in marked contrast with the poverty-stricken hauls which characterized the trawling in the line of Admiralty Islands to Japan.

On the line Hawaiian Islands to Tahiti, at Station 264, lat. 14° 19′ N., long. 152° 37′ W., in a depth of 3000 fathoms, Tahiti distant 1920 miles and Hawaii about 300 miles, only one specimen of Cladorhiza was obtained and fragments of a Euplectella. One hundred miles further south, at

Station 265, lat. 12° 42′ N., long. 152° 01′ W., in 2900 fathoms, obtained only one specimen of Gonostoma. At Station 270, lat. 2° 34′ N., long. 149° 09′ W., two species of deep-sea Keratosa were obtained in 2925 fathoms, Tahiti distant about 1200 miles. At Station 271, lat. 0° 33′ S., long. 151° 34′ W., about half-way between Hawaii and Tahiti, in 2425 fathoms, nine species of Keratosa, six of Hexactinellidæ, and, in all, twenty-nine species of Invertebrates and Fishes exclusive of Protozoa. At the next station, 272, lat. 3° 48′ S., long. 152° 56′ W., in 2600 fathoms, sixteen species of Invertebrates and Fishes were collected. At Station 274, lat. 7° 25′ S., long. 152° 15′ W., Tahiti and the Marquesas about equidistant, 625 miles, Caroline Island 202, and Vostok Island 160 miles. At Station 276, lat. 13° 28′ S., long. 149° 30′ W., in 2350 fathoms, Tahiti distant 240 miles, only six species (10 specimens) of Invertebrates and Fishes are recorded from the trawl, while the hauls off Tahiti, though poor, contained again a comparatively large number of specimens and species.

On the line from Tahiti to Valparaiso the hauls at Station 280, 1940 fathoms, and at Station 281, 2385 fathoms, distant from Tahiti less than 200 miles south, again showed a very great diminution in the number of specimens and species collected in the trawl. A similar condition exists at Stations 285, lat. 32° 30′ S., long. 137° 43′ W., and 286, in depths of 2375 and 2335 fathoms, about 1300 miles southeast from Tahiti and nearly 600 miles south of the islands of the southeast extremity of the Paumotus. The fauna at Station 289, lat. 39° 41′ S., long. 131° 23′ W., about 250 miles southeast of Station 285, in 2550 fathoms, was equally poor.

From Station 289 the "Challenger" ran a line nearly east towards Valparaiso, distant 2907 miles. At Station 291, lat. 39° 13′ S., long. 118° 49′ W., in 2250 fathoms, only two species of Monaxonida were obtained. At Station 293, lat. 39° 04′ S., long. 105° 05′ W., in 2025 fathoms, an Actinarian and fragments of siliceous sponges and Gorgonians and Polyzoa were obtained attached to manganese nodules; Valparaiso distant 1661 miles. One specimen of Holopsamma was obtained at Station 294, lat. 39° 22′ S., long. 98° 46′ W., in 2270 fathoms, Valparaiso distant 1368 miles. At Station 295, lat. 38° 07′ S., long. 94° 04′ W., one fish (Cyema) was collected in the trawl, which is also, like Gonostoma, probably a fish belonging to

the pelagic types, and a Leptocephalid form of Nemichthys. At Station 296, lat. 38° 06′ S., long. 88° 02′ W., about 500 miles from Juan Fernandez, seventeen species (twenty specimens) of Invertebrates were obtained in 1825 fathoms, Globigerina ooze, and at the next station, 297, lat. 37° 29′ S., 302 miles from Juan Fernandez, only a single specimen of Thenea is recorded; while at Station 298, lat. 34° 7′ S., 122 miles from Valparaiso, nearly 100 specimens of Invertebrates were obtained, belonging to thirty-three species, and the hauls from Valparaiso south to the Gulf of Peñas, in 1325 to 2160 fathoms, at no time more than 450 miles from shore, in blue mud or Globigerina ooze, were also rich in specimens and in species, compared with hauls taken in deep water and far from continental slopes or large archipelagos.

The following are the results of the trawling of the "Albatross" during her present cruise in the tropical Pacific.

MANGANESE NODULES FROM STATION 2.

At Station 2, 2368 fathoms, lat. 28° 23′ N., long. 126° 57′ W., the trawl came up with the bag full of red clay and of manganese nodules, siliceous sponge spicules, a large pink Benthœcetes, spines of Phormosoma, Euphronides, and Benthodytes in fragments. Together with the manganese nodules came up many sharks' teeth, whale ear-bones and other fragments

of cetaceans more or less coated with manganese. There were a number of species of sharks represented: Charchaordon, Lamna, Oxyrhina, Carcharias. There were also a number of flat slabs coated with manganese, the majority from three to four inches thick, but many were nearly six inches through. We must have brought up at least 800 pounds' weight of nodules. The slabs seemed to be composed of volcanic ash. There were many rounded masses of pumice covered by manganese and fragments of the stem of a Gorgonian (Isis) coated with manganese.

At this Station we obtained 116 sharks' teeth, a few ear-bones and other bones of whales and dolphins.

Note. — Sir John Murray informs me that at Station 2 some of the material which seemed to be manganese nodules proved to be rocks, evidently of continental origin, covered with a thin coating of manganese.

Mr. J. J. H. Teall, of the Geological Survey of England, who examined these rocks, reports that they are a fragment of a rounded pebble, consisting of a typical hornblende andesite; a subangular fragment of a pale-green serpentine; an angular fragment of a fine-grained sandstone composed of grains of quartz, felspar, and epidote, minute grains of mica being also present; fragments of a well-rounded pebble of black chert, traversed by microscopic quartz veins.

How these pebbles, having all the characteristics of glacial-worn pebbles, came to be carried to this point is an interesting question. As the shark's-teeth and cetacean bones found in the red clay seem to indicate that since tertiary times there have been but very insignificant deposits at great distance from continental areas, similarly we may be tempted to assume that these pebbles, which could not have been transported to their present locality by any agency of the present epoch, were carried to it during the glacial epoch, the thin coating of manganese indicating how small have been the bottom deposits since the glacial period.

The "Challenger" obtained two bushels of manganese nodules at Station 281, south of Tahiti, lat. 22° 21′ S., long. 150° 17′ W., in 2385 fathoms, with centres of volcanic tufa and larger slabs covered at the surface and in the cracks. The rounded masses of pumice probably have been carried out to sea for a long distance and finally sinking became coated with manganese on falling in the red clay deposit. This locality of the "Challenger" is only about 300 miles from our Station 173, where we also obtained a magnificent haul of red clay and manganese nodules and sharks' teeth.

From south of Tahiti on the way to Valparaiso the "Challenger" also obtained manganese nodules at Stations 285, 286, 289, in 2375, 2335, and 2550 fathoms; and further to the east, at Stations 293 and 297, in 2025 and 1775 fathoms. The "Challenger" also found manganese nodules in 2160 fathoms, about 100 miles from the coast of South America, as well as in the Atlantic far from continental land, and at one station in the Indian Ocean in 2600 fathoms; but the "Challenger" obtained none north of the Equator, either in the Atlantic or in the Pacific, so that this first haul of ours in lat. 28° 23′ N. and long. 126° 57′ W., as well as hauls further south on our way to the Marquesas, greatly extend the area over which such deposits of manganese nodules and red clay probably exist, — areas which, according to Murray, are situated in deep water and far from continental land, too far from land to be masked by telluric deposits, and at too great a depth to be covered by the shells of Foraminifera and other pelagic animals, as suggested by Murray. The "Valdivia" obtained manganese nodules in the Southern Atlantic in lat. 30° 34.9′ S., long. 6° 10.2′ W., about 2600 fathoms.

We could find no spherules of cosmic iron in the few samples of manganese nodules which we ground to powder.

In the track of great oceanic currents Globigerinæ shells extend to greater depths, and their tests are found mixed with red clay quite frequently at depths quite beyond those at which they ordinarily disappear; see Stations 14 to 22, on our way to the Marquesas, where the deposit is a Globigerina ooze at depths far beyond those at which, according to Murray, Globigerina ooze should occur, — in depths of 2776, 2440, 2463, 2495, and 2287 fathoms.

At Station 10, in 3088 fathoms, lat. 16° 38′ N., long. 136° 14′ W., we lowered the "Blake" trawl. Unfortunately there was no evidence of the trawl having been on the bottom, although we had as much wire-rope out in proportion to the depth as in other hauls. The net came up clean, and although it towed open through such an immense length of column of water, the net contained nothing which we had not caught with the tow-net inside of 200 fathoms from the surface. It had so called deep-sea fishes, — Cyclothone and Myctophum, — and deep-

sea Crustacea, which are obtained in the open tow-nets at less than 150 fathoms from the surface.

At Station 13, in 2690 fathoms, lat. 9° 57′ N., long. 137° 47′ W., red clay, Radiolarian ooze, light-brown ooze. The "Blake" trawl came up full of large manganese nodules, balls varying in diameter from $4\frac{1}{2}$ to over 6 inches; a few of the largest measured $6\frac{1}{4}$″ in diameter. The bottom contained some animal life, but of course in their long passage to the surface, among such a mass of rubble, the delicate deep-sea animals come up very much disfigured and ground to pieces. Attached to some of the nodules we found pink Webbinas, a small Voluta (?), three species of Holothurians, among which one brilliant red I could recognize as a Peniagone. We found also a fragment of a stem of Bathycrinus, half a dozen joints or so, and part of the upper portion of a Metacrinus (?), a small Brachiopod (Magasella ?) and a few worm-tubes, large siliceous spicules, and a species of incrusting siliceous sponge, together with delicate calcareous worm-tubes attached to some of the flat nodules, and some Serpulæ tubes. A few Schizopods found their way into the trawl-net on its way to the surface. There were also large reddish-brown Globigerinæ, evidently living at that depth in the interstices of the manganese nodules,[1] a large red Nemertean allied to Pelagonemertes, and a small tough-skinned gray-white Actinian measuring about an inch in diameter when contracted. We also brought up the same egg-shaped organism with a thin greenish skin about half an inch in diameter, found by the "Blake" and former "Albatross" expeditions, the nature of which I have not been able to determine. The manganese nodules were all more or less mammary; this is specially well-developed in the flat pieces.

Station 17, 2463 fathoms, lat. 0° 50′ N., long. 137° 54′ W., fine, light-gray, yellowish Globigerina ooze. An excellent haul was made with the "Blake" trawl, considering its depth and its distance from the nearest land;

[1] Dr. Mayer kept surface Globigerinæ in the dark for three weeks. They were brilliant carmine when collected, and at the end of that time had lost all their color and had become quite pale, like those found at the bottom. The only colored Globigerinæ we found on the bottom were those living attached on the surface or between the cracks of manganese nodules. These were dull reddish-brown, with much heavier and coarser tests than the carmine or colored species living at the surface or near it.

but it being on the line of the equatorial current, it also shows the effect of the increased supply of food carried by a great oceanic current. This haul is a striking contrast to those taken farther south to the southeast of Tahiti at about the same depth, but outside the range of any great current. In that district we found practically nothing living on the red-clay bottom. It seems natural to infer that the lines of migration of the deep-sea fauna of the tropical Pacific must have been along the track of the equatorial current.

The trawl contained three species of Holothurians, one of which was bright carmine; a number of siliceous sponges, among which a small Hyalonema with its Zoanthus attached to the bundle of spicules; a few colossal spicules nearly as thick as a lead pencil; a lot of the Neusina we collected in 1891 in the Panamic region; two species of Actiniæ, one of which a brilliant carmine, the other heavy, thick-skinned, whitish, both found attached to siliceous spicules; a species of Archaster, and a good specimen of Linopneustes; a peculiar fish with a long head and pectoral fins, spread vertically upright across the flanks, and having two long caudal filaments; a few manganese nodules, and a number of small sharks' teeth; a couple of specimens of Scalpellum, and what I took to be fragments of the interesting Ascidian Octacnemus of Moseley. Some of the large siliceous spicules must have been 24″ long. Also a small white, thick, stiff-armed Ophiuran; some worm-tubes built up in part of mud and of siliceous spicules; two excellent specimens of Terebella, a Pectinaria-like worm, and great numbers of Radiolarians collected from the intestines of the Linopneustes; two specimens of Amusium; a Gasteropod; a Webbina attached to Neusina; a small Plumularian; a fragment of a Polyzoan; and a Eucopia which found its way into the net near the surface. The list of the contents of this trawl-haul is quite sufficient, when contrasted to that of the haul at Station 173, to emphasize the contrast between localities in the wake of the great equatorial current and those outside of its influence.

At Station 25 we lowered the beam-trawl in 830 fathoms, lat. 8° 48′ S., long. 139° 48′ W., in the channel between Nukuhiva and Washington Islands, the bottom being Globigerina ooze and volcanic mud. The trawl

tripped, but brought up three specimens of Mopsea and an Astroschema attached to it, of a pinkish-orange color, three Actiniæ (Stephanactis), pink in color, with warty columns, a Pheronema, and pieces of siliceous sponges. A second haul in the same place brought up a couple of small manganese nodules, surface fishes, Sternoptyx, and Cyclothone; a large black Malacosteus, like the Malacosteus indicus of Günther, with long barbels, a large eye, and a comma-shaped, phosphorescent organ, green-yellow at the point; the phosphorescence was quite brilliant when the fish was placed in the dark. The spot was $\frac{5}{6}''$ long, the eye itself was a beautiful dark carmine. The net also contained Atolla Alexandri of Maas, and a specimen of the thick-nosed phosphorescent surface fish, Ganadis, three red deep-water prawns, two specimens of Benthesicymus. The latter we have had from 300 fathoms in the open tow-net.

At Station 31, in 2700 fathoms, lat. 12° 20′ S., long. 144° 15′ W. Red clay. The sea being a little too heavy for a successful haul, the "Blake" trawl came up with the net badly torn; it must have had too heavy a load of manganese nodules, as the part of the bag left contained about a plate full of small, irregularly shaped nodules, incrusting also volcanic rock. The net probably gave away as we broke ground, judging from the indications of the accumulator.

There is a marked contrast between the hauls on this oceanic line (Stations 1–72) and our results in the "Albatross" expedition of 1891, when never more than 700 miles from shore. We always made excellent hauls, and there seemed to be an ample food supply on the bottom of that area, brought by currents and winds from the mainland.

At Station 73 we lowered the trawl in 807 fathoms, lat. 17° 27′ S., long. 149° 32′ W. Fine volcanic sand, Pteropods. It brought up a mass of fine volcanic mud filled with sticks and leaves and decayed vegetation, fragments of rocks and other telluric material, pieces of sugar cane, and fragments of cocoanut shells. In addition, in the midst of this mixture, one Holothurian, a Willemoesia, broken shells, fragments and specimens of Hyalea and many other Pteropod shells, also fragments of Lamellibranchs.

At Station 133 we lowered the trawl in 742 fathoms, lat. 18° 05′ S., long. 142° 23′ W. Pteropod ooze. The trawl came up in pieces; the

pocket of the bag contained a piece of obsidian as large as a hen's egg, a piece of pumice and of coral, both coated with manganese, a few fragments of wood similarly coated, a fragment of Tubipora, also coated, and a mass of Globigerinæ connected by manganese, as well as volcanic fragments and particles of manganese.

At Station 134, in 807 fathoms, lat. 18° 06′ S., long. 142° 24′ W. Fine coral sand and minute manganese nodules and Pteropod ooze. We sent the swabs down; brought up two specimens of Brisinga, a couple of small Diadematidæ, fragments of a Gorgonian stem coated with manganese, a few young siliceous sponges and fragments of others, two species of Ophiurans, and fragments of a Bryozoan. Also some small manganese nodules and sharks' teeth. A poor haul for such a depth and such a bottom.

At Station 139, in 812 fathoms, lat. 18° 08′ S., long. 141° 04′ W. Coral sand. The "Blake" trawl brought up a fine Brisinga, a couple of genera of Gorgonians, a Galathodes, a piece of stem of an Isis, young siliceous sponges, a fine Penæus from intermediate waters (?), and some Ophiurans, — in fact, the same things we brought up at Station 134 in the tangles. The ground must have been very rough, as the trawl caught repeatedly, and when it reached the surface was found badly torn along the sides.

At Station 173, in 2440 fathoms, lat. 18° 55′ S., long. 146° 32′ W. Red clay. The "Blake" trawl brought up about half a ton of flattened manganese nodules, generally mammilated on the surface, and slabs of all sizes, from that of a large potato to that of a pea. Many of the nodules were spherical or ellipsoidal. Many of the flattened pieces contained large sharks' teeth; there were but few ear-bones or other bones of cetaceans. Some of the sharks' teeth were fully 4″ long.

At Station 183, in 2472 fathoms, lat. 19° 04′ S., long. 167° 41′ W. Red clay washed out. Radiolarian ooze, volcanic particles. The "Blake" trawl came up with a large hole on the side and the bottom partly carried away, yet there were still left in the bag a number of small flat manganese nodules, from the size of a small walnut down. The bag also contained a few pieces of pumice and one shark's tooth, a few siliceous sponge-spicules, and fragments of a small siliceous sponge.

At Station 185, in 4173 fathoms, lat. 21° 18′ S., long. 173° 31′ W. Light-brown volcanic mud and Radiolarian ooze. A small "Blake" trawl was lowered, protected by canvas flaps; it came up in excellent condition. A half-gallon jar was filled with fragments of a large siliceous sponge allied to Aulochone or Crateromorpha which the "Challenger" obtained in shallower water, in about 500 fathoms, in the western Pacific.

The bottom deposits collected by the "Albatross."

A comparison of the deposits collected by the "Albatross" on the line from San Francisco to Tahiti with the "Challenger" line of soundings from Station 253 north of the Hawaiian Islands to Tahiti shows a great similarity in their characteristic structure. At Station 2 (lat. 28° 23′ N., long. 126° 51′ W.), in only 2368 fathoms, the "Albatross" struck the characteristic Pacific red clay which was met with as far as Station 14 (lat. 6° 41′ N., long. 137° W.), where in 2776 fathoms Globigerinæ and Foraminifera predominated and no Radiolarians occurred, while at next station, in 2583 fathoms, Radiolarians were again obtained, as well as at Station 18 (lat. 6° 25′ S., long. 138° 59′ W.), in 2468 fathoms, and at Station 23 (lat. 8° 33′ S., long. 139° 36′ W.), in 1802 fathoms, near the Marquesas, together with volcanic particles. At the intermediate stations, varying in depth from 1939 to 2463 fathoms, Globigerina ooze was obtained. It may be stated that Stations 14 to 23 are in a general way in the tract of the equatorial current and counter current, characterized by the larger number of species constituting its surface fauna than in the stations to the north.

Note.—Sir John Murray in his Report on the bottom deposits has frequently called attention to the great bulk of pelagic Foraminifera which are found in the bottom deposits. While it is true that many of the Globigerinæ of which the tests are collected must live at or very near the bottom[1] yet the pelagic species, which are far less numerous, often compose fully 80 per cent of the carbonate of lime occurring in the deposit. According to Brady he records as collected by the "Challenger" only 19 species of pelagic Foraminifera: seven of Globigerinæ, six species of Pulvinulina, and the following genera, Orbulina, Hastigerina, Sphæroidina, Candeina, Cymbalopora and Chilostomella, represented each by one species. But they occur on the surface in such swarms that their dead tests, when they reach the bottom, completely overwhelm those of the bottom living species.

[1] W. B. Carpenter, in Proc. R. S., Vol. XXIII., p. 235.

The same may probably be said of the Radiolarians. The surface Radiolarians are less numerous than the species living near the bottom, but the pelagic species occur in such hosts as to outweigh at certain localities those living on the bottom. The number of pelagic species of Radiolarians[1] is far greater than that of the Globigerinæ, and there are no groups of the former living attached to the bottom, as in the case with the arenaceous and porcellanous types of Foraminifera. On the other hand there must be living and floating in close proximity to the bottom, far from continents and at depths greater than 2000 fathoms, hosts of abyssal Radiolarians, among which the Nasselaria and the Phæodaria predominate. As a general rule the abyssal forms are characterized by their smaller size and massive skeletons, while the surface types are distinguished by their more delicate skeletons.[2] The surface and pelagic Radiolarians probably do not extend far beyond 200 fathoms in depth, and belong especially to the Spumellaria and Acantharia, and, according to Haeckel, with but few Osculosa, and fewer Phæodaria than Nassellaria. Unfortunately, no detailed account of the bathymetrical range of the minor groups of Radiolarians accompanies the report of Haeckel,[3] but he naturally attaches the greatest significance to the dependence of their geographical distribution on oceanic currents.

The bottom deposit at the stations in the vicinity of the Marquesas are characterized by an admixture of Globigerina ooze and volcanic particles. In the channel separating the Marquesas from the northwestern Paumotus, a distance of not more than 450 miles, the deeper parts, in from 2456 fathoms to 2700 fathoms, are marked by all the characteristics of the deposits in the deeper parts of the eastern Pacific north of the Marquesas; the deposits passing from red clay associated with Radiolarians to red clay mixed with Foraminifera, and in the lesser depths, 1208 fathoms to 1932 fathoms, we meet with deposits consisting of Globigerina ooze, and finally coral sand in the vicinity of the Paumotu Plateau.

Again in the channel separating the Paumotus from the Society Islands a deposit allied to red clay, composed in part of Globigerinæ, was found in the deeper parts at a depth of somewhat over 2200 fathoms; the Globigerinæ becoming mixed with large proportions of volcanic mud as we approached the Society Islands.

[1] Haeckel enumerates more than 4300 species, and remarks that probably twice that number could be distinguished from a more detailed examination of the "Challenger" material. Report on the Radiolaria collected by H. M. S. "Challenger," 1887, Zoölogy; Vol. XVIII., First Part, p. ii.

[2] Haeckel, l. c, p. clii.

[3] Haeckel, l. c., p. cxlvi.

Through the Paumotu Archipelago the soundings in less than 1400 fathoms are marked by the frequent occurrence of Pteropod ooze and of Globigerinæ, but by far the greater number of soundings show a bottom made up of Globigerinæ and of coral sand in proportion to the distance from the atolls; the coral sand being coarser nearer the shores, gradually becoming finer as we proceed seaward, and at the same time containing a larger percentage of Globigerinæ or of Pteropod shells. Compare the records of the shallower stations in the northwestern Paumotus, such as Stations 79, 89, 91, 96, 106, 107, 115 to 117, made up of comparatively coarse coral-sand, with deeper stations like 82, 97, 104, 109, at which the coral sand is finer, containing a larger percentage of Pteropods or Globigerinæ, and with the still deeper stations like numbers 77, 87, 93, 94, 102, 103, 110–114, where the Globigerinæ make up the greater part of the deposit.

A similar state of things is found to hold good with the deposits at the stations occupied in the central Paumotus, as well as in the easternmost islands of the Paumotus we visited. When the depths separating the islands are greater, as at Station 146 (lat. 18° 56′ S., long. 139° 05′ W.) and 152 and 154 to 157 (lat. 20° 46.5′ S., long. 142° 51′ W.), on the way from Pinaki to Nukutipipi, we find again red clay in depths varying from 2284 to 2467 fathoms containing a greater or less percentage of Foraminifera. Similarly at Stations 166 and 167 (lat. 20° 02′ S., long. 144° 28′ W.), in the deep water which separates Anu Anuraro from Hereheretue, in 2265 and 2524 fathoms, the bottom deposit is red clay with an admixture of Foraminifera; while at stations varying in depth from about 700 fathoms to nearly 2000 fathoms the deposit is made up of coral sand, Pteropod ooze, and Globigerinæ in different percentages, as in the deposits of the northwestern Paumotus.

The deep soundings between Hereheretue and Tahiti at Stations 172 and 173 (lat. 18° 55′ S., long. 146° 32′ W.) were made up of red clay and Globigerinæ; and on approaching Tahiti the coral sand which characterized the vicinity of the atolls in the Paumotus is replaced in the Society Islands by volcanic mud and volcanic sand and a small percentage of Globigerinæ.

One cannot fail to notice the frequent occurrence of particles of manganese and of small manganese nodules in the deposits through the Paumotus and Society Islands.

In the deep water between Niue and Tonga which culminates at Station 186 (lat. 21° 18′ S., long. 173° 51′ W.) in 4540 fathoms, we meet with red-clay deposits containing Radiolaria, as at Stations 183 (lat. 19° 04′ S. long. 167° 41′ W.), 184, and 185 in 2472, 3141, and 4173 fathoms, though at Station 182 the red clay in 2882 fathoms contained a considerable percentage of Globigerinæ.

On the way from Vavau to Fiji we found volcanic mud to the westward of Lotté while crossing the volcanic ridge which runs parallel to the Tonga Islands Plateau. Crossing the eastern Fiji Plateau we meet with deposits of coarse coral-sand, Pteropod ooze, and fine coral-ooze, associated with manganese particles and Globigerinæ, much as in the deposits of the Paumotus.

On our way through the Ellice and Gilbert Islands to Jaluit we obtained in the proximity of the islands coarse coral-sand, Pteropod ooze, and fine coral-sand ooze more or less mixed with Globigerinæ. In the deeper waters separating the islands of each group, and the groups themselves, we encountered only Globigerina ooze, varying greatly in the size of the species obtained; very coarse species being met with at Stations 198, lat. 0° 46′ N., long. 173° 09′ E., and 202 in the Gilbert group in 1365 and 1569 fathoms.

At Station 197, in 2221 fathoms, between Apamama and Maiana, we met with the same Globigerinæ, characterizing the equatorial current, which we had obtained before in the Paumotus and to the northward. Although on our way to Jaluit from Taritari we sounded in over 2500 fathoms, yet we nowhere obtained red clay in the bottom deposit, either on that line or in the deep water separating the islands of the Ellice or of the Gilbert group. See Stations 197, 2221 fathoms; 204 (lat. 1° 52′ N., long. 173° 15′ E.), 2156 fathoms; 206, 2255 fathoms; 208 (lat. 3° 57′ N., long. 172° E.), 2486 fathoms; 209, 2505 fathoms; 210, 2414 fathoms; 211 (lat. 5° 20′ N., long. 169° 43′ E.), 2411 fathoms; at all of which Globigerina ooze was obtained. We found the same conditions in the Marshall group, coarse coral-sand, passing, according to depth and distance from land, into fine

coral-sand, or coral-sand ooze, with a gradually increasing percentage of Globigerinæ. These are met with in as great a depth as 2613 fathoms, at Station 213 between Jaluit and Ailanglab Lab and all through the Marshall group in deep water in the channels between the different groups. See Stations 219, 2179 fathoms; 226, 2231 fathoms; 229, 1583 fathoms; 232, 2221 fathoms; 233–234, varying from 1009 fathoms to 2486 fathoms; while in the shallower stations referred to above, such as Stations 216, 1968 fathoms; 218, 631 fathoms; 221, 400 fathoms; 222, 827 fathoms; 227, 228, 230, in 468, 934, and 482 fathoms, — we find that the bottom deposits contain coral sand, changing from coarse to fine and then to ooze with the increase in depth.

Red clay is, however, met with in the bottom deposits of the northern part of the Marshall group between Rongelab and Likieb at Stations 223–225, in depths varying from 2469 to 2609 fathoms, though even at that depth it is associated with a considerable percentage of Globigerinæ.

Similarly on our way through the Carolines we found Globigerinæ to constitute a considerable percentage of the bottom deposits to depths of nearly 2500 fathoms. See Stations 240, 241, lat. 6° 49′ N., long. 156° 36′ E.; 243, 244, lat. 8° 06′ N., long. 151° 08′ E. The bottom deposits in the Carolines consist, as we would naturally expect from the geological structure of the Carolines, near the island groups, in great part of volcanic mud mixed with coral sand and Globigerinæ; the size of the sand, volcanic or coral, gradually decreasing as the depth increases. See Stations 239 and 242.

It is only as we pass into the "Caroline Deep" separating the Carolines from Guam and the Ladrones that we come upon bottom deposits consisting of red clay, manganese nodules, and pumice, as well as volcanic particles. See Stations 245, 2735 fathoms; 246, lat. 10° 34′ N., long. 148° 25′ E., 2993 fathoms; 247, lat. 11° 35′ N., long. 147° 15′ E., 3213 fathoms; 248, lat. 12° 51′ N., long. 145° 46′ E., 4813 fathoms; and as we approach Guam at Station 249, in 2337 fathoms, we come upon deposits of fine volcanic sand.

No soundings were made by the "Albatross" on the line from Guam to Yokohama, as the line is parallel for a considerable length with that run by the "Challenger" from the Admiralty Islands to Japan. In addition

there are numerous soundings by the "U. S. S. Nero" for a proposed cable line between Guam and a point nearly west in the Philippines, as well as a very complete line from Guam to Japan. These soundings, with a line to the east of Guam also run by the "Nero," give an excellent idea of the topography of that part of the Pacific. The character of the bottom unfortunately is not indicated on the charts issued by the U. S. Hydrographic Office[1] to show the interesting soundings of the "Nero," under commander Belknap, two of which are the deepest soundings as yet taken.

The following is the record of the surface hauls made by the "Albatross."

Station 1. Lat. 31° 10′ N., 125° W. 300 miles from Point Conception. Neither Copepods nor Sagittæ, Collozoum, Pleurobrachia, Euphausia, Macrurans, Hyperia, Schizopods, Thysanopoda, Hyalea, Turris, Dyphies, Agalma, Aglaura, Oceania, Pyrosoma, Salpæ, Carinaria, young fishes.

Station 2. Lat. 28° 23′ N., long. 126° 57′ W. Very poor surface haul. 500 miles from Point Conception. Few Macrurans, Euphausiæ, Collozoum, young flying-fish, transparent Prionotus (?) fish eggs, Aglaura, Velella, Abyla, tentacles of a Siphonophore on the stray line, which could not be identified.

Surface haul. Lat. 28° 11′ N., long. 127° 16′ W. Large Ctenophores like Mertensia; an elongated, flask-shaped Cydippe; Salpæ, Isopods, Pteropods, young fishes, Macrurans.

Station 3. Lat. 26° 18′ N., long. 128° 54′ W. Large blue Copepods. Collozoum, Euphausia, two specimens; Sagittæ, Geryonia, young flying-fish. Very poor haul.

Station 4. Lat. 24° 30′ N., long. 130° 16′ W. Halobates, brilliant red Globigerinæ; Collozoum, three or four species; two large blue Copepods, a few small fishes, young flying-fishes; young Ianthinæ; young Velella.

Station 5. Blue Copepods, brilliant carmine Globigerinæ, Pteropods, Spirialis, Diphyes, Collozoum.

Station 6. Lat. 20° 26′ N., long. 133° 28′ W.; Saphirinæ and a few Copepods; Collozoum, the same as thus far obtained, young flying-fish and other small fishes; Globigerinæ; many small lilac Ostracods (poor haul).

[1] H. O. Charts, 528, 529.

Station 7. Lat. 18° 19′ N., long. 134° 57′ W. Very poor haul. Small Physalia; small blue and black Copepods; Globigerinæ; young flying-fish, and young of other pelagic fishes; fragments of Pyrosoma.

At 8 P. M., made a very successful haul in lat. 17° 32′ N., long. 135° 40′ W., on the same date as at Station 7. Small transparent Taonius, Copepods, Euphausiæ, Sergestes, embryos of Hyperia, Atlanta, and Styliola, Alcyope, Porpita, Halobates, bells of Diphyes and of Agalma, Crystalloides, Sagitta, very large species, Firoloides, 2 species of Salpæ, Collozoum. We collected in great abundance all the species we obtained in the morning at Station 7, from 150 fathoms, and then to the surface.

Station 12. Lat. 12° 07′ N., long. 137° 18′ W. This haul contained Collozoum, and a few Globigerinæ; small blue, yellow, and brown Copepods were quite abundant. At 8 P. M. of same day, in lat. 10° 57.6′ N., long. 137° 35.4′ W., made a surface haul. Euphausiæ were very abundant, small phosphorescent fishes, and many other young surface fish, Copepods, three species of Pteropods, Spirialis, Salpæ, three species of Sergestes larvæ, small Macrurans, Halobates. This haul being so successful, we made a second one immediately after it, and obtained very little; the same things were collected, but fewer in number, and the absence of Euphausiæ in this second trial was especially marked.

Station 13. Lat. 9° 57′ N., long. 137° 47′ W. In this surface haul we collected practically all the so-called deep-sea types which came up in the "Blake" trawl when dragging from 3088 fathoms to the surface. On the surface Porpitidæ were common, as well as flying-fishes; we were evidently in the equatorial current. The net contained very many small Sagittæ, and small Copepods, only a few large ones. Atlanta, Hyalea, Spirialis, Thysanopoda, Nyctophanes, Nematocelis, Stylocheirus. A very young Physalia, the youngest yet observed, was drawn by Dr. Mayer. Young Diphyes. There were no Euphausiæ in this haul. We made a second surface-haul at the same place and obtained the same things and in addition Halobates. Same date, surface-haul at 8.30 P. M., lat. 9° 26′ N., long. 137° 49′ W., very much like that of the previous night, without the surface fishes, only one young fish, Spirialis, Tiedemannia, Cuvieria, Euphausiæ, Amphipods, Sergestes, Hyperia, large blue Copepods, and a few others,

large Sagitta. Collozoum, Globigerinæ, Geryonia, Aglaura; not so many Euphausiæ as on the previous day, when they formed a perfect paste.

Station 14. Lat. 6° 41′ N., long. 137° W. Very good haul. Apparently still in the equatorial current, judging from the amount of animal life in the surface-hauls. Blue Copepods, a large Saphirina, Salpæ in great abundance, the principal part of haul consisted of them; Glaucus, young Cuttle-fish, several species of young pelagic fishes, a fine lot of Collozoum. No Euphausiæ, Sergestes very common, young Physaliæ, Nausithoë, Aegina, Diphyes.

Same day, 8 P. M., lat. 5° 40′ N., long. 136° 47′ W. Huge Pyrosomæ, beautifully phosphorescent, were very abundant, Salpæ, Sergestes, a few Copepods, Euphausiæ, large Hyperidæ, a few transparent Penæids, young fishes, large Appendiculariæ, Cydippe, same species obtained before, Geryonia, Cestum, large Sagittæ, and few smaller ones.

Station 15. Lat. 4° 35′ N., long. 136° 54′ W. Very poor haul. Few Copepods, Diphyes, bells of Agalma, large transparent fish-eggs, a few Sagittæ, Collozoum, and Halobates.

Same day, 8 P. M. Lat. 3° 28′ N., long. 136° 54′ W. A small black, blunt nosed fish, with luminous organs, a small fish with phosphorescent organs, hosts of Salpæ, at least three species, Cydippe, Aglaura, Rhopalonema moving by convulsive jerks of the velum, Turris-like Medusa, small flying-fish, huge Appendicularia houses, small Appendiculariæ, two Copepods and Euphausiæ, Hyperia, Penæus with very long tentacles. Sagittæ, bells of Diphyes and of Agalma, many Radiolarians in the stomachs of Salpæ. It is astonishing how many Radiolarians and Globigerinæ the "Challenger" obtained in the open tow-nets; our experience near the line in the Pacific has thus far been quite the contrary.

Station 16. Lat. 2° 38′ N., long. 137° 16′ W. Poor surface haul. A few Salpæ, Copepods, Argulus, Collozoum, Sagittæ, the same as before; young Physalidæ, the same Medusæ as at Station 15. Turris (?). Euphausia, Penæus, young Balanus larvæ, Diatoms, a fine large Tiedemannia; colder current running to Westward at rate of two knots.

Same day, 8 P. M. Lat. 1° 45′ N., long. 137° 36′ W. Net full of surface animals, mainly small Sagittæ, Appendiculariæ, very many Sergestes, small

Copepods, a few Euphausiæ, Balanus larvæ, small Salpæ, Cydippe, Geryonia, Rhopalonema, a few Collozoum, Liriope hyalinea of Fiji, Halobates, small black phosphorescent fishes, large Pteropod, Cuvieria.

Station 17. Lat. 0° 50′ N., long. 137° 54′ W. The surface haul at this station contained nothing of importance.

Station 18. Lat. 6° 25′ S., long. 138° 59′ W. Surface haul very poor. Collozoum, a few Sagittæ and Copepods, two small fishes.

Station 25. In the channel between Nukuhiva and Washington Islands. Very poor. A few Sagittæ, a blue Copepod, and Collozoum.

Station 26. Lat. 8° 52′ S., long. 139° 52′ W. Very poor haul. Collozoum, Sagittæ, small black Copepods and others, Mysis, Halobates, young Physalia, and Geryonia, — same species as before, — small fish-eggs, many small solitary Salpæ, or isolated zooids, Appendicularia with iridescent tail, Ianthina, Halobates.

Sept. 15. At anchor in Anna Maria Bay, Marquesas. Collected with the electric light a number of large Appendicularia houses, new Diphyes.

Station 30. Lat. 10° 29′ S., long. 141° 52′ W. Many Ianthinæ and Firoloides, Sagittæ, Collozoum, Diphyes, a few Copepods, fish-eggs, small Diodon, Sergestes larvæ, Orbulina in very fine condition, large Appendiculariæ, no Euphausiæ, Agalma bells, Salpæ.

Station 31. Lat. 12° 20′ S., long. 144° 15′ W. Ordinary haul. Sagittæ, two small Copepods, many Lucifer, medium-sized Appendiculariæ, Firoloides, many Ianthinæ with Lepas parasites, Porpita and Physalia quite common; Diphyes bells, Carmaris, perhaps the same species as that described by Haeckel, as found off Peru.

Station 31. 7 P. M., same day. A good surface-haul containing Salpæ, Doliolum, three species of Copepods, black, pink, and red, Lucifer, Phronima, a large red species, a small red crab, adult of a red Zoea collected yesterday; large Sergestes, fine transparent specimens; Atlanta, Rhopalonema, Lyriope hyalina, Diphyopsis.

Station 32. Lat. 13° 37.5′ S., long. 145° 42′ W. Sagittæ, four species of Copepods, Lucifer, Hyperinæ, Firoloides, Salpæ, a large species of Appendicularia, two species of young fishes, Agalma, a new genus of Diphyes allied to a genus collected at the Marquesas.

Station 35. Lat. 14° 42′ S., long. 147° 08′ W. 8 P. M., at anchor off Avatoru Pass. Cydippe, Phronima, Appendicularia, and Copepods.

September 23. Surface-haul in Rangiora Lagoon near anchorage. Many Appendiculariæ, Sagittæ, Cydippe, Rhopalonema, Epenthesis, first time we have found Hydroids. No Crustacea.

It is to be noted that in the Pacific, far away from land, we only meet Narcomedusæ, Cunanthidæ, and the like, while Hydroid Medusæ are found near shores. The same result was obtained by the "Plankton" Expedition.

Station 48. Off Avatoru Pass, Rangiroa. An excellent haul, containing small phosphorescent fishes, Squillæ larvæ, Zoeæ; Penæids, with red at base of antennæ, many Copepods, Euphausiæ, transparent larvæ of many shore genera of Brachiurans and Macrurans, Syllis, Goniodactylus, larvæ of Scillaridæ, Nausithoë, two species of Rhopalonema, Cydippe, Diphyopsis, Pelagia, Octopus, Pteropods, Appendiculariæ, Halobates, Collozoum, Salpæ, Sagittæ.

Station 73. Lat. 17° 27′ S., long. 149° 32′ W. Very poor haul; only obtained one small flounder and one Cyema.

At 7 P. M. on the same day an excellent haul was made, containing large and small Sagittæ, Salpæ, large Appendiculariæ, Agalma bells, Diphyopsis, Rhegmatodes, Stomobrachium, Aglaura, Amphipods, two species of Penæids, one fine Nyctophanes, a red Copepod, blunt-headed black fish with phosphorescent organs, also young of large-headed fish with phosphorescent organs, Sergestes, larvæ of Willemoesia, no Euphausiæ, three species of Pteropods, Cuvieria, Styliola, Alciopa, Collozoum.

Station 133. Lat. 18° 05′ S., long. 142° 23′ W. A very poor haul, containing a small flying fish, Abyla, Diphyopsis, Collozoum.

Station 139. Lat. 18° 08′ S., long. 141° 04′ W. A very poor haul, containing only Pneumodermon larvæ and small Salpæ, a couple of Copepods, Diphyes bells, and Collozoum.

Station 173. Lat. 18° 55′ S., long. 146° 32′ W. A poor haul, with two species of Collozoum, three of Copepods, Diphyopsis, and Agalma bells.

As is shown from the surface hauls made in the Paumotus, the number of pelagic animals is quite small, and even the few successful hauls did not compare in richness with those made while crossing the equatorial current. We had a similar experience with our surface hauls while cruising through

the leeward Society Islands, the Cook, and Tonga Archipelagos, as will be seen from the record which follows: —

Nov. 16. Near the west side of Huaheine. Calm. Very poor haul: a few Copepods, Collozoum, mass of Trichodesmium. At anchor in Hurepiti Bay, Tahaa. By electric light a fair haul was made of Copepods, Polygordius, young Tamoya, Lucifer, many crustacean larvæ, mainly Brachiurans, many Ostracods, Styliola.

Nov. 17. At Bora Bora, 8 P.M., we obtained from the surface haul Ostracods, Lucifer, Appendiculariæ, Sagittæ, Squillæ larvæ, Megalops, small fishes, Macrurans, Ctenophores; very poor in Copepods. A second haul made with electric light contained mainly Crustaceans, specially Ostracods, also Sagittæ and Appendiculariæ.

Nov. 24. Station 183. Lat. 19° 04′ S., long. 167° 41′ W. A very poor haul: a few Collozoum, four small Copepods, one Ostracod.

Nov. 29. A surface haul made at Tongatábu by electric light contained only four Copepods.

Dec. 4. A surface haul at Vavau by electric light brought together quite a number of young fishes, a few Copepods and Schizopods, Halobates, and young Linerges.

Dec. 23. About one mile off shore, off the north entrance to Funafuti. A few Copepods, Collozoum, Tomopteris, pelagic fishes, and two species of Halobates.

Jan. 1, 1900. Off the south shore of Tarawa. Collected by electric light large numbers of embryos of Crustacea and young fishes.

Jan. 5. At Taritari anchorage. Collected by electric light an immense number of Copepods, together with pelagic Annelids, Autolytus, young fishes, and many embryos of shore Macrurans and Brachiurans.

Jan. 18. At anchor, Rongelab. A surface haul by electric light brought a large number of embryos of Crustacea and of young fishes.

Station 222. About one and a half miles south, off the southeast pass, of Rongelab. A surface haul obtained only Collozoum and one blue Copepod.

Jan. 20. At anchor in Likieb lagoon. Surface haul by electric light obtained Autolytus, many Annelids, young fishes, and larvæ of Macrurans and Brachiurans.

Jan. 22. At anchor in Wotje. Surface haul by electric light; obtained mainly young fishes and larvæ of shore Crustacea, a good many Copepods, and a few Annelids.

Jan. 24. At anchor in Arhno lagoon. Made a surface haul by electric light; obtained young Squid, fishes, Sagitta, Bolina, Macruran larvæ, and Copepods.

Jan. 27. A second haul made at the Arhno anchorage by electric light obtained many Squid, young fishes, many Copepods, Nereis and Heteronereis-like Annelids, and larvæ of Macrurans.

Feb. 26. At our anchorage in Truk we obtained a number of phosphorescent Annelids skimming over the surface, appearing as brilliant luminous spots, and extending, as the animal moved rapidly, into long, thin, tortuous lines from one to two feet in length.

We did but little towing at Fiji, where I had done considerable work off Suva during a former visit in the winter of 1897–1898 while cruising through the group in the "Yaralla." The pelagic material collected at that time, as well as the collections made by Dr. Woodworth at Samoa in 1898, will be incorporated with the reports on similar material obtained by the present expedition. We were greatly surprised at the extreme poverty of the surface hauls made within the atolls wherever we anchored in the Ellice, Gilbert, or Marshall Islands, with the exception of a haul made by electric light in Taritari, when the nets came up filled with a swarm of Copepods, with many young Annelids, larvæ of Brachiurans and Macrurans, as well as young fishes.

We had a similar experience when towing in the Carolines in the belt of the trades. In fact, the poverty of the surface fauna of the regions of the Pacific which we traversed (far from land) was very marked, with the exception of the limited tract while crossing the equatorial current, as contrasted to the abundance of animal life found in the Panamic district, or in the track of the Gulf Stream and in the West Indian area.

This renders it far more difficult to obtain data for the bathymetrical and geographical distribution of the pelagic fauna of the Pacific, and until far more extensive material has been brought together, the localization of the surface faunæ of the Pacific realm must be left in a very indefinite state.

All we may assert at present is that there is a great intertropical belt extending north and south of the equator twenty or twenty-five degrees of latitude and reaching from the Central American district west, as far as the East Indian Archipelago. The surface fauna of this extensive area is quite uniform and has a wide geographical range in longitude; while both north and south of it we have the temperate surface fauna, which in latitude passes gradually into a subarctic and subantarctic fauna. The tropical fauna is characterized by the greater number of genera and species and the small number of individuals of each. As we proceed north or south into the temperate or subarctic and subantarctic regions the diversity of the fauna shows a marked diminution in the number of genera and species, with a corresponding increase in the number of individuals of the species characteristic of the temperate and of the more northern or southern belts. As regards the correlation of the fauna of these different regions in depth and in latitude, the material available for such a comparison has not yet been sufficiently worked up.

Hauls made at intermediate depths by the "Albatross."

To supplement the surface hauls the open tow-nets were sent to tow at depths varying from 100 to 400 fathoms, and after having dragged at certain depths they were run up to the surface open, thus mixing the materials which might have been obtained at different depths by closing-nets. One cannot fail to be struck with the fact that the nets sent down to these greater depths did only in very few instances collect any forms which might be said to live in intermediate depths, as compared with those collected in the surface hauls.

At the following stations hauls with the open tow-net (unless otherwise stated) were made by the "Albatross" at definite depths for a limited time, then the open tow-net was dragged to the surface. The legend is as follows, viz.: Station 1. At 300 fathoms and to surface; meaning that the open tow-net was dragged at a depth of 300 fathoms generally twenty to twenty-five minutes, and then dragged to the surface and contents of net examined. Other stations have a corresponding legend. The net was kept practically at the depth indicated by means of the clinometer in use on the "Albatross."

Station 1. Lat. 31° 10′ N., long. 125° W. At 300 fathoms and to surface. Large Copepods, Larvæ of Balanus, Ostracods, Macrurans; the same Oceania and Diphyes as on the surface; Hyalea, Carinaria, a transparent Alciopa; dead Globigerinæ and Orbulinæ.

Station 2. Lat. 28° 23′ N., long. 126° 57′ W. At 350 fathoms and to surface. Tentacles of Siphonophores. Bathyphysa came up entangled on the dredging wire. Gnathophausiæ, Hyperidæ, many Copepods, Euphausiæ, a Scopeloid, large Tomopteris with violet band in middle, and white flappers. Second haul: 100 fathoms and to surface. Remarkable fish with pedunculated eyes, Macrurans, Copepods.

Station 3. Lat. 26° 18′ N., long. 128° 54′ W. At 200 fathoms and to surface. Large blue Copepods, numerous small white Copepods, yellowish-brown Copepods. 660 miles to Point Conception. Collozoum, young flying-fish, Sagittæ, Euphausiæ, Phronima, Firoloides, Hyalea, Cuvieria, Styliola, Geryonia with six canals; very transparent Alcyopidæ.

Station 4. Lat. 24° 30′ N., long. 130° 16′ W. At 500 fathoms and to surface. Numerous large Copepods, blue, brown, and red; one with red anterior part of carapace; small Copepods, red and white; Euphausiæ, Ostracods, Saphirina, small transparent Alciopa, Styliola, a Rhizophysa 12″ long attached to the wire rope; Diphyes bells, Collozoum. Collected nothing which had not been obtained when towing at 200 fathoms.

Station 5. Lat. 22° 42′ N., long. 131° 54′ W. At 150 fathoms and to surface. Many large gray and brown Copepods, large red Copepod, Pteropods, large Sagitta, Diphyes, mutilated Taonius.

Station 6. Lat. 20° 26′ N., long. 133° 28′ W. At 150 fathoms and to surface. Small Copepod with black appendages (subsequently often found), large red and brown Copepods, Cydippe, Collozoum, Globigerinæ, Styliola, Sagitta, Sergestes larvæ, small Taonius, Amphipods, and a large Stenorhynchus.

Station 7. Lat. 18° 19′ N., long. 134° 57′ W. At 150 fathoms and to surface. Fair haul of Copepods, Euphausiæ, Phronimæ, Cystosoma, Sergestes, small black Copepods, large pink Copepods, Firoloides, Sagitta; fragments of a large transparent Solmaris.

Station 12. Lat. 12° 07′ N., long. 137° 18′ W. At 150 fathoms and to surface. Excellent haul, Agalma, Diphyes, large Æginа, all Copepods of

large species; large transparent Amphipod; Salpæ with large red nucleus; large Sagittæ, Collozoum; marked absence of Euphausiæ and other pelagic Macrurans, no Rhizopods on the surface; Pteropods, many Atlanta, Hyalea, Styliola, Cuvieria, Tiedemannia; very active large Ostracod of reddish color and with a transparent shell; Appendiculariæ, Globigerinæ, Amphyon Reynaudi. The Salpæ were full of Radiolarians of the same species as those brought up from the bottom in the sounding-cup.

Station 14. Lat. 6° 41′ N., long. 137° W. At 150 fathoms and to surface. In general the same things as at the surface. Leptocephalus, Salpæ and many Pteropods, Pyrosoma, young fishes, Siphonophore bells, many Squilla embryos, Oxyrhynchus, also Sergestes, not many Copepods, the few collected were very large.

Station 15. Lat. 4° 35′ N., long. 136° 54′ W. At 150 fathoms and to surface. Large Cestum, a few Copepods and Euphausiæ, Eretmocaris, large white Macruran, small Saphirina-like Copepod, the same Salpæ as yesterday, very large Atlanta, Spirialis, Styliola, a few Tomopteris, Sagitta, the remarkable Tunicate, Octacnemus, figured by Moseley, a few colonies of a small Pyrosoma, Globigerinæ, Halobates.

Station 16. Lat. 2° 38′ N., long. 137° 16′ W. At 250 fathoms and to surface. Fine haul. Many Pelagothuriæ, Diphyes, Diphyopsis, Turris, Leptocephalus, young fishes and mollusks, Copepods, Penæids, Euphausiæ, Tomopteris, and other pelagic worms; Pteropods, Hyalea, Atlanta, Styliola, Spirialis, Sagittæ, Salpæ; the Salpæ full of Radiolarians; Collozoum, no Globigerinæ or Radiolarians at surface.

Tanner net, at 330–350 fathoms. In the closed lower bag only a couple of Copepods were obtained. In the open upper bag four species of fishes, Pelagothuriæ, a number of large red Schizopods, Penæids, and large red Copepods, Sergestes, large transparent Phyllodoce with spots on the side, a large Ostracod with chocolate-brown colored shell, all of which have been obtained before at a less depth.

Station 18. Lat. 6° 25′ S., long. 138° 59′ W. At 400 fathoms and to surface. Net carried away; too rough. Fragments of Sigalion, a couple of young fishes, small Octopus, large Copepods, a few Euphausiæ, a large Bentho-

caris, the same that was obtained in the trawl by the "Challenger" (Pl. 123) in a depth said to be two miles deep. We may safely assume that the majority of the Gnathophausiæ and Schizopods are not from the bottom, but live near the surface; also that all Macrurans with swimming appendages are not necessarily from the bottom. Penæids with and without powerful swimming appendages, but long-legged types like Nematocarcinus, come from the bottom. Dr. Moore, who carefully examined the three species of Macrurans we brought up from the unsuccessful trawl, in 3088 fathoms, says they have all been found at less than 100 fathoms. The same may be said of the fishes collected in that haul.

Station 26. Lat. 8° 52′ S., long. 139° 52′ W. At 300 fathoms and to surface. Several red Penæids and so-called deep-sea fishes, Euphausiæ, Sergestes larvæ, Annelids, and fragments of transparent pelagic Annelids, Sagittæ, young Sternoptyx and other species of young fishes, Salpæ, Aglaura, large bells of Diphyes, Penæid with long antennæ, the same as that obtained in haul from 830 fathoms!

Station 27. Lat. 9° 01′ S., long. 140° 04′ W. At 300 fathoms and to surface. Fine lot of Penæids with long antennæ, Scopelids, Euphausiæ, Zoeæ of shore Brachiurans, a fine Nemichthys! so-called deep-sea fish; Leptocephalus, and three other species of small fishes; Actiniæ embryos, Tanais, Agalma bells, Diphyes, and a new genus of Diphyes with opaque bells, a large Pilidium measuring half an inch, Sergestes, Pandalus, a short Tomopteris with marked yellow patches at the base of the flappers.

Station 30. Lat. 10° 29′ S., long. 141° 52′ W. At 300 fathoms and to surface. Two species of phosphorescent fishes, a young Diodon, Euphausiæ, a few Copepods, a large red Zoea, Carinaria, Firoloides, Styliola, Hyalea, a small Siphonophore, Agalma bells, transparent Annelids and the large Pilidium again, Sagittæ, Tomopteris, Alciopa, and other species of worms, Salpæ, Gasteropods in the veliger stage.

Station 32. Lat. 13° 37′ S., long. 145° 42′ W. At 300 fathoms and to surface. Five species of fishes, Euphausia, three species of large Copepods, Lucifer, Sergestes, Oxycephalus, the same large Pilidium as before, Rhopalonema, Diphyopsis, Abyla.

Oct. 5. Off Point Venus, Tahiti. At 350 fathoms and to surface. Atlanta, and small fishes. Wire parted, net inside out.

Station 91. Off Fakarava. At 350 fathoms and to surface. Very poor haul. A Tamoya, the young of the large Charybdea caught off Anaa(?) Euphausia, Sagitta, young fishes, two species.

Oct. 28. Two miles off Marokau (west shore). At 300 fathoms and to surface. Very poor haul. Sagitta, Salpæ, Diphyes, Abyla, large Cuvieria. Among the Paumotus the surface fauna is very poor; we have seen little or no phosphorescence while steaming through the group until on the night when making Aki Aki, when there seemed to be a little more pelagic life, judging by the phosphorescence.

Station 173. Lat. 18° 55′ S., long. 146° 32′ W. Half way from Hereheretue to Mehetia. At 100 fathoms and to surface. Poor haul. Diphyes, Liriope, Euphausia, Abyla, Sagitta, Copepods, Saphirina, Collozoum very abundant, two forms of colonies, Penæids, Tomopteris, Syllis, a small species of Salpæ, large Appendiculariæ. At the same locality, at 300 fathoms and to surface, we obtained exactly the same things, with the addition of a few Pteropods, Cuvieria.

Dec. 23. One mile off the north entrance to Funafuti. At 150 fathoms and to surface. Smooth water, very bright day. Brought up Beroë, Liriope, Bougainvillia, Sagitta, several species of Copepods, pelagic Annelids, Tomopteris, Pteropods, a large pink Appendicularia, Schizopods, Saphirina, Collozoum, a few red Globigerinæ, larvæ of Macrurans and Brachiurans.

At Station 222, about one and one half mile south, off southeast pass into Rongelab. At 150 fathoms, and to surface. Excellent haul. Obtained Firoloides, Sagitta, Pteropods, Criseis, Cuvieria, several species of brilliantly colored Copepods, red, blue; a transparent Argulus-like Crustacean, Collozoum, Solmaris, transparent pelagic Annelids, Taonius, several species of Macrurans, Salpæ, the stomachs of which contained many Radiolarians.

Dr. Woodworth made a few hauls with the Krämer quantitative nets.

Eight of the hauls are pairs, taken inside and outside of lagoons.

One pair, three quarters mile off the east point of Funafuti, at fifteen fathoms in 250 fathoms, and from fifteen fathoms close to bottom, inside of lagoon, half a mile from the village.

One pair, one and a half miles off the south point of Rongelab, at fifteen fathoms in 450 fathoms, and inside at our anchorage, at twelve fathoms one mile from the shore.

One pair, half a mile off South Pass into Likieb, at fifteen fathoms in 468 fathoms, and inside of Likieb Atoll at our anchorage, at ten fathoms.

One pair, one mile off South Pass into Wotje, at 30 fathoms in 482 fathoms, and one mile inside Rurick Pass, at our anchorage, at fifteen fathoms in twenty-two fathoms.

A single haul off the southeast point of Tarawa, in fifteen fathoms in 200 fathoms; a single haul, at our anchorage in Arhno Lagoon, at fifteen fathoms in twenty fathoms.

All these showed an excess of organic life in the lagoon as compared with that obtained outside of the lagoons. It does not strike me as if the results obtained heretofore, or the few data we collected, were of great value in determining the question of the proportion of food supplies to corals growing inside of a lagoon or on its sea faces, either on the weather or lee side.

The conditions inside of a lagoon are very different from those outside, and depend greatly upon the depth of water on the weather rim of the lagoon, the extent of the land-rim, the number and dimensions of the passages leading in and out of the lagoon on the weather or lee side, and the trend of the lagoon as related to the prevailing winds.

In a lagoon which is comparatively shut out from the general circulation of the waters surrounding it, we naturally have conditions radically different from those lagoons in which the prevailing winds drive over the submerged rim of the weather-side a mass of water, pouring into the lagoon all the surface organisms of the adjoining sea. Such a closed lagoon is Pinaki, for instance. The amount of pelagic life which finds its way into its shallow lagoon through the narrow gap communicating with the sea must of necessity be very small compared to the mass of water driven into such a huge lagoon as Wotje, of which so great a part of the outer rim is submerged, with one to six fathoms; and again, quite a different state of things must exist in the interior of a lagoon of which the rim on the

lee side is made up of large islands, and on the weather-side of shallow flats separated by narrow gaps, allowing but a comparatively small amount of water to be driven into the lagoon from that side. In a semi-closed lagoon like Pinaki there are but few corals, when compared to those found in such an open lagoon as Wotje, and there are none growing in the closed lagoon of Niau.

The fact remains that the corals growing on the sea face of an atoll or of a barrier or fringing reef are far more massive and abundant than those which grow inside of the lagoon. While it cannot be denied that the corals of the lagoon are in many localities more numerous in species, yet they never extend to as great a depth, and never have the luxuriant growth or form the colossal heads which characterize those of the sea face.

Furthermore, the amount of animal life, irrespective of corals, which finds its sustenance on the sea face of a reef is very great, and its superabundance does not seem to indicate a lack of food-supply as compared with that existing in the lagoon.

To be of value it seems to me that these quantitative experiments should be accompanied with a comparative statement of the amount of water sifted through each lagoon, as it were, in which the experiments are conducted. And furthermore, the amount of animal life coming to the surface, or living to a depth of ten or fifteen fathoms outside of any atoll, must be fully as fluctuating a quantity in these regions as it is known to be elsewhere, depending upon the season, the time of the day, and atmospheric conditions, all of which are still unknown factors to us, not only in the Pacific, but even at localities where observations on the relative abundance of surface organisms, and the causes which influence it, have been carried on for many years.

The record of the observations of the surface temperatures and of the specific gravities of the sea were in charge of Dr. H. F. Moore. Of course, until the record has been carefully computed, we can compare it only in a very general way with the results obtained in the Pacific by the "Challenger" as tabulated by Dr. Buchanan,[1] and specially with Plate 5

[1] Physics of the "Challenger" Expedition, Vol. I., London, 1884.

of the "Atlas of the Pacific," issued by the German Observatory in 1896,[1] giving the lines of the specific gravity based upon a large amount of material accumulated by a number of exploring expeditions down to 1893.

The observations of the "Albatross" practically agree with Plate 5 of the German Observatory Atlas, showing a gradual increase as we proceed south from San Francisco to the vicinity of the Society Islands and in the Paumotus, with a maximum specific gravity on the line San Francisco to Tahiti. In a general way we found also a somewhat greater salinity in the lagoons, as at Rangiroa, Fakarava, Makemo, in the Paumotus, as well as in the Tongas, Fiji, the lagoons of the Ellice, Gilbert, Marshall, and Carolines, at Funafuti, Taritari, Jaluit, Rongelab, Wotje, Arhno, Ualan, Ponapi, Truk, and Guam in the Ladrones.

As we proceed westward from the Society Islands there is a gradual and very marked diminution in the specific gravity, reaching its minimum in the Fijis. Thence it again diminishes rapidly northward at the Ellice, Gilbert, and reaches on that line its minimum in the southeastern Marshall Islands. It rises again in the northern Marshall Islands and going west from Jaluit is somewhat less along the Carolines, falling again as we go north to the Ladrones, and thence to Japan, with the exception of a slight rise to the west off the Bonin Islands.

The Bottom Deposits collected by the "Challenger" in the Pacific.

The chart given by Murray and Renard,[2] showing in general the nature of the bottom deposits of the Pacific, naturally does not give the interesting details for each sounding, showing the relation of the constitution of the bottom deposits to the depth. As the line run by the "Albatross" shows in a remarkable manner the same correspondence which had been first observed by Sir John Murray between the amount of carbonate of lime present and the depth, I have, for purposes of comparison, collected the data of the principal stations occupied by the "Challenger" in the Pacific, to show how closely the later observations of the "Albatross" agree with the records of the "Challenger."

[1] Deutsche Seewarte, Stiller Ozean, Ein Atlas v. 31 Karten, Hamburg, 1896.

[2] Chart 1: Deep-sea Deposits, "Challenger" Expedition, Murray and Renard.

In the western Pacific the line run by the "Challenger" from the Admiralty Islands to Japan, shows the following:[1]

At Station 220, lat. 0° 42′ S., long. 147° E., 1100 fathoms, Globigerina ooze,[2] seven species of Radiolarians were obtained from the bottom deposit.

The Radiolarians from the deposit at Station 224, lat. 7° 45′ N., long. 144° 20′ E., in 1850 fathoms, were represented by nearly thirty species, and by about sixty species of Foraminifera, 88 per cent of the carbonate of lime of the deposit being represented by pelagic species.

At Station 225, lat. 11° 24′ N., long. 143° 76′ E., in 4475 fathoms, Radiolarian ooze; over 350 species of Radiolarians are noted from the deposit, and ten from the surface. The deposit indicates only a trace of carbonate of lime, while at Station 226, lat. 14° 44′ N., long. 142° 13′ E., in 2300 fathoms, the red clay contains 6.11 per cent of carbonate of lime, and in 2475 fathoms, Station 227, lat. 17° 29′ N., long. 141° 21′ E., only a trace of carbonate of lime occurs, as well as at Stations 228, 229, 230, 231. At Station 229, lat. 22° 01′ N., long. 140° 27′ E., in 2500 fathoms, red clay, the deposit was characterized by numerous Diatoms. At Station 231, lat. 31° 08′ N., long. 137° 08′ E., in 2250 fathoms, blue mud, the number of species of Radiolarians in the deposit was greatly reduced, not more than ten being noted at that station.

It is interesting to note in the line Admiralty Islands to Yokohama that the Globigerina ooze is found in what we may call, in a general way, the equatorial current, between Stations 220 to 224, while the Radiolarians extend as far north as Station 231, taking their greatest development, apparently, in the belt of the trades, from Station 225 to Station 230. On the line from Yokohama to the Hawaiian Islands blue mud was brought up at the first station east of Japan, No. 237, in 1875 fathoms, with 4.45 per cent of carbonate of lime, made up of about 100 species of Foraminifera, 33 per cent of the carbonate of lime in the deposits being made up of pelagic species. The deposit at this station is also characterized by the large number of species of Diatoms it contains. Globigerina ooze was brought up only at Station 246, in 2050 fathoms. At all the other stations

[1] John Murray, Observations at each of the "Challenger" Stations.

[2] See Murray and Renard, Voyage of the "Challenger," Deep-Sea Deposits.

red clay was obtained, with either no carbonate of lime or only a trace of it, except at Stations 241 and 247, the deposit of which contained, in the one case 10 per cent, in the other 17.29 per cent of carbonate of lime. At Station 241, lat. 35° 41′ N., long. 157° 42′ E., in 2300 fathoms, seventy species of Foraminifera were obtained, nearly sixty per cent of which is made up of half a dozen of pelagic species. Nearly fifty species of Radiolarians and twenty-five of Diatoms are also recorded from the deposit at that station.

At the second station from the Japanese coast (Station 238, lat. 35 18′ N., long. 144° 08′ E.), in 3950 fathoms, red clay, the number of species of Radiolarians in the deposit is limited to two, and it only contains fifteen species of Foraminifera.

At Station 244, lat. 35° 22′ N., long. 169° 53′ E., in 2900 fathoms, red clay, there are mentioned as found in the deposit over thirty species of Foraminifera and nearly 100 species of Radiolarians.

At Station 245, lat. 36° 23′ N., long. 174° 31′ E., in 2775 fathoms, red clay, not more than ten species of Radiolarians are recorded as found in the deposit.

At Station 246, lat. 36° 10′ N., long. 178° E., in 2050 fathoms, Globigerina ooze, where the deposit contains 56.07 per cent of carbonate of lime, over 100 species of Foraminifera are recorded, and 62 per cent of the carbonate of lime is composed of pelagic species.

At Station 247, lat. 35° 48′ N., long. 179° 57′ W., in 2530 fathoms, red clay, ten species of Radiolarians are recorded. A few more species of Radiolarians are recorded at Station 250, lat. 37 49′ N., long. 166 47′ W., in 3050 fathoms, red clay, together with about thirty species of Diatoms. At the next station, in 2950 fathoms, Diatoms were also common. Radiolarians are limited to nine species in the deposit of Station 252, lat. 37 52′ N., long. 160° 17′ W., in 2740 fathoms, red clay.

At the northeasternmost point reached by the "Challenger" in the Pacific (Station 253, lat. 38 09′ N., long. 156 25′ W.), in 3125 fathoms, red clay, forty species of Foraminifera are recorded, four of which are pelagic, while the number of species of Radiolarians has increased to about sixty. On the line due south from Station 253 in the direction of the

Hawaiian Islands, fifteen species of Foraminifera, three of which are pelagic, and eight species of Radiolarians are recorded from Station 256, lat. 30° 22′ N., long. 154° 56′ W., in 2950 fathoms, red clay, and in forty fathoms, off the Honolulu reef, eighty-two species of Foraminifera are recorded in the deposit, only 3 per cent of which is made up of seven pelagic species.

The line from Yokohama east to Station 253, lat. 38° 09′ N., long. 156° 25′ W., and thence south to the Hawaiian Islands, is marked for the great number of Radiolarians recorded in the deposits of the different stations, as well as for the number of surface Radiolarians. It will be noticed that the above line follows the general trend eastward of the Japanese current and that the fauna of the bottom appears to be far more abundant in the track of this great oceanic current than in the line running south of Japan, where no great oceanic currents occur.

On the "Challenger" line, Hawaii to Tahiti, which corresponds more to the "Albatross" line, only two of the soundings (Station 270, lat. 2° 34′ N., long. 149° 09′ W., and 271, lat. 0° 33′ S., long. 151° 34′ W.) indicate Globigerina ooze, and both of them are far beyond the depth at which such deposits are usually met with. The "Albatross" had a similar experience at Stations 14, lat. 6° 41′ N., long. 137° W., in 2776 fathoms; 16, lat. 2° 38′ N., long. 137° 16′ W.; 17, lat. 0° 50′ N., long. 137° 54′ W., in 2440 and 2463 fathoms. The above-mentioned soundings of the "Challenger" were in 2925 and 2425 fathoms, and both in the belt of the equatorial current. With the exception of the stations nearest the Hawaiian Islands and Tahiti, which showed a deposit of volcanic mud (Stations 262, 263, and 278), the other stations on that line were all red clay, with little or no trace of carbonate of lime. Though Station 269, lat. 5° 54′ N., long. 147° 02′ W., in 2550 fathoms, approaching Stations 270, lat. 2° 34′ N., long. 149° 09′ W., and 271, lat 0° 33′ S., long. 151° 34′ W., contained 20 per cent of carbonate of lime, made up of more than thirty species of Foraminifera, seven of which were pelagic species, composing about 85 per cent of the carbonate of lime; the rest of the deposit consisting of over sixty species of Radiolarians and over eighty species of Diatoms.

Of the Globigerina ooze Stations No. 270, 2925 fathoms, contained 71.47 per cent of carbonate of lime, and 271, in 2425 fathoms, over 80 per cent;

the latter deposit containing over ninety species of Foraminifera, no less than eighteen of which are pelagic and make up 86 per cent of the deposit. Yet at this station nearly 600 species of Radiolarians are recorded by Haeckel as occurring in the deposit, and about thirty species of Diatoms. The station south of the equatorial belt (272, lat. 3° 48′ S., long. 152° 56′ W., in 2600 fathoms) also contained 10.19 per cent of carbonate of lime, and Station 273, lat. 5° 11′ S., long. 152° 56′ W., in 2350 fathoms, still further south, only 2 per cent; the number of species of Radiolarians occurring in the deposit at Station 272 being reduced to about 270 in number and to about 110 at Station 273. At Station 274, lat. 7° 25′ S., long. 152° 15′ W., the carbonate of lime is nearly 4 per cent and the Radiolarians in the deposit number over 175 species.

In 2350 fathoms, Station 276, lat. 13° 28′ S., long. 149° 30′ W., there is 28.28 per cent of carbonate of lime in the red clay, and over 110 species of Foraminifera, sixteen of which are pelagic and make up 88 per cent of the carbonate of lime. Station 277, in 2325 fathoms, has over 9 per cent of carbonate of lime. Station 278, lat. 17° 12′ S., long. 149° 43′ W., 1525 fathoms, over 20; and other stations in the vicinity of the volcanic mud contain a varying amount of carbonate of lime. At Station 279 it contains nearly sixty species of Foraminifera, four of which are pelagic and make up 33 per cent of the carbonate of lime.

On the line from Tahiti to Valparaiso the soundings (Stations 281–282) in red clay south of Tahiti, though not more than 2450 fathoms in depth, show but a trace of carbonate of lime, while the soundings to the eastward, somewhat less in depth but in Globigerina ooze, carry from 65 to 26 per cent, and are in the line of the southeast trades (Station 283, lat. 26° 09′ S., long. 145° 17′ W. to 286, lat. 33° 29′ S., long. 133° 22′ W.). There are nearly forty species of Foraminifera recorded from the deposit of Station 280, south of Tahiti in 1940 fathoms, thirteen of which are pelagic species, making up 84 per cent of the carbonate of lime, and at Station 284, lat. 28° 22′ S., long. 141° 22′ W., there are eighty species noted as found in the deposit in 1985 fathoms, sixteen species of which are pelagic, making up 74 per cent of the carbonate of lime, which constitutes 65 per cent of the deposit. In a somewhat deeper station, 285, lat. 32° 36′ S., in 2375

fathoms, red clay, and with 26.25 per cent of carbonate of lime, the Foraminifera recorded are reduced to fourteen species, only one of which is pelagic and yet makes up 76 per cent of the carbonate of lime. The Foraminifera are accompanied by about fourteen species of Radiolarians. At Station 286, lat. 33° 29′ S., long. 133° 22′ W., 2335 fathoms, with 25.13 per cent of carbonate of lime in the red clay, there are sixty species of Foraminifera, seven of which are pelagic, constituting 60 per cent of the carbonate of lime.

At Station 288, lat. 40° 03′ S., long. 132° 58′ W., in 2600 fathoms, over forty species of Radiolarians are recorded from the surface, only six at Station 289 (2550 fathoms), and four at Station 290 (2300 fathoms), nearly twenty at Station 291, lat. 39° 13′ S., long. 118° 49′ W., in 2250 fathoms. When we come again to the Globigerina ooze stations, containing from 5 to 71 per cent of carbonate of lime in the deposit, we find nearly sixty species of Foraminifera. At Station 293, lat. 39° 04′ S., long. 105° 05′ W., in 2025 fathoms, with nearly 45 per cent of carbonate of lime, ten species of Foraminifera are pelagic and constitute 78 per cent of the carbonate of lime, accompanied by sixteen species of Radiolarians. At Station 295, in 1500 fathoms, though in 38° south latitude, Juan Fernandez distant nearly 800 miles, eighteen species of Radiolarians were collected at the surface. Five species of surface Radiolarians extended even to Station 298, lat. 34° 07′ S., long. 73° 56′ W., in 2225 fathoms not more than 120 miles from Valparaiso; and over twenty-five species of Radiolarians are recorded from the deposit of that station in blue mud mixed with over twenty species of Diatoms.

At Station 296, lat. 38° 06′ S., long. 88° 02′ W., in 1825 fathoms, Juan Fernandez distant about 500 miles, over eighty species of Foraminifera are recorded from the Globigerina ooze, fifteen of which are pelagic and make up 85 per cent of the carbonate of lime, of which 64.34 per cent is contained in the deposit, together with six species of Radiolarians.[1]

South of Valparaiso to the Gulf of Peñas the Globigerina ooze is marked again for the great number of species of Foraminifera recorded from the

[1] For the distribution of the bottom deposits in the Pacific, see Chart 1 Deep-sea Deposits, "Challenger" Expedition, by Murray and Renard.

deposits at Stations 299, 2160 fathoms; 300, 1375 fathoms; 302, 1450 fathoms, accompanied by a small number of Radiolarians. At Station 300 there are over 140 species of Foraminifera found in the deposit and nearly fifty species of Radiolarians. Only five of the species of Foraminifera are pelagic, yet they make up 83 per cent of the carbonate of lime which constitutes over 54 per cent of the deposit at that station.

The Surface Organisms observed by the "Challenger" in the Pacific.

A comparison of the surface animals taken from the records of the "Challenger" with those obtained by the "Albatross" can at present only show in a very general way their distribution.

The observations of the "Challenger" have not as yet been tabulated with reference to the geographical range of the surface organisms.[1] It is hoped that a beginning may be made when the records of the present Expedition of the "Albatross" are properly arranged. It will be practicable, then, to give some general idea of the distribution of such types as the transparent Annelids, the Pteropods, the Salpæ, and other Tunicates, the pelagic fishes, and Cephalopods. But by far the greatest mass of material relating to surface animals consists of the pelagic Crustacea, the greater number of which consist of the Copepods; next come the Schizopods and Macrurans, the Brachiurans being comparatively few in number. The Ostracods are also fairly numerous. From a cursory examination we can state that the surface fauna of the tropical Pacific has a very wide geographical range, a great many of the species reaching from the coasts of Central America to the shores of the western Pacific.

On the "Challenger" line, Admiralty Islands to Japan, at Station 220, lat. 0° 42′ S., long. 147° E., the surface haul was characterized by Diatoms, Globigerinæ, Dyphies, Siphonophores, Sagitta, Alciopa, Saphirina, Copepods, Hyperia, Oxycephalus, Lucifer Zoëæ, Pteropods, Appendicularia, Salpæ, Doliolum, and young fishes.

At Station 221, lat. 0° 48′ N., long. 148° 41′ E., red clay, in 2650 fathoms, a number of Diatoms were obtained from the surface, as well as Globigerinæ, Schizopods, Macrurans, Cephalopods, young fishes, and much

[1] John Murray, Bathymetrical and Geographical Distribution.

the same species of Copepods, Annelids, Siphonophores, Pteropods, and Tunicates, as in Station 220; a very similar assemblage of surface animals was also obtained at Stations 222, 223, 225, 226, 227, 228, 229, 230, 231, as far as Japan, varying somewhat in the relative abundance of Diatoms, Radiolarians, Globigerinæ, Copepods, Pteropods, Tunicates, and Annelids.

At Station 225, lat. 11° 24′ N., long. 143° 16′ E., the surface fauna, as noted by Dr. Willemoës Suhm, was especially rich, and the same may be said of Station 230, lat. 26° 29′ N., long. 137° 57′ E.; at Station 229, lat. 22° 01′ N., long. 140° 27′ E., Velella, Porpita, Ianthina, and Glaucus make their appearance, having been but seldom taken before on the way from the Admiralty Islands. At Station 231, near the Japanese coast, the character of the water changed, and the tow-nets were filled with Diatoms and Noctilucæ, and the proximity of a land mass was clearly indicated by the change in the surface fauna.

As regards the surface organisms on the "Challenger" line, — Japan to Hawaii, — at Station 237, lat. 34° 37′ N., Long. 140° 32′ E., off the coast of Japan, no less than seventeen species of Radiolaria are recorded from the surface, together with Copepods, Pteropods, Tunicates, and young fishes as well as Annelids, Siphonophores, Ctenophores, Sagittæ, Euphausia, Lucifer, Cyprinidæ, Cuttle fish, Noctiluca, Diatoms, and Globigerinæ; very much the same surface organisms occur at Stations 238, lat. 35° 18′ N., long. 144° 08′ E., where the character of the hauls was again quite oceanic; 239, 240, lat. 35° 20′ N., long. 153° 39′ E., where Copepods were specially numerous; 241, 242, 243, lat. 35° 24′ N., long. 166° 35′ E., with the addition of Halobates, Appendicularieæ, Doliolum, Saphirinæ, Phronima, Phyllosoma, Tomopteris, Oxycephalus, Orbulina, Hastigera, and Diatoms in varying quantities.

At Station 244, lat. 35° 22′ N., long. 169° 53′ E., the number of species of surface Radiolarians recorded is not less than forty-five. These have diminished again to thirteen at Station 245, lat. 36° 23′ N., long. 174° 31′ E. There are also about the same number recorded from Stations 247, lat. 35° 48′ N., long. 179° 57′ W.; 248, 249, lat. 37° 59′ N., long. 171° 48′ W.; 250, 252, lat. 37° 52′ N., long. 160° 17′ W., and 253; though at the last station the surface Radiolarians have increased in number to over thirty species. At Stations 254, lat. 35° 13′ N., long. 154° 43′ W., 255, 256, lat.

30° 22′ N., long. 154° 56′ W., Physalia appears, and the Radiolarians vary from twelve to seventeen species. At Station 257 there are not more than four species recorded for the surface, off Molokai there were not more than five surface Radiolarians obtained, and at Station 260, in the centre of the Hawaiian group, there are recorded from the surface: Diatoms, Globigerinæ, many Radiolarians, and other pelagic animals, such as Medusæ, Siphonophores, Sagittæ, Annelid larvæ, Copepods, Hyperids, Euphausia, Pteropods, Tunicates, and Gasteropod larvæ, though in the other groups of pelagic animals there has been, as a general rule, a very marked uniformity in the surface hauls.

The (open) tow-nets at Station 241, lat. 35° 41′ N., long. 157° 42′ E., were sent to sixty fathoms, and at Station 246 they were sent into deep water, and when brought up contained all the things found at the surface and additional Radiolarians different from those found at the surface.

At Station 247, depth 2530 fathoms, lat. 35° 48′ N., long. 179° 57′ W., the (open) tow-nets were sent down to 1200 and 1500 fathoms, and many Radiolarians "abundant in deposits, but only *rarely* taken in the surface nets" (the italics are mine). On the surface at Station 249, lat. 37° 59′ N., long. 171° 48′ W., the stomachs of the Cirriped Zoëæ were filled with Coccospheres, Coccoliths, Rhabdospheres and Rhabdoliths, and their excrements were composed of masses of these small Algæ and Diatoms. The stomachs of Euphausiæ contained the remains of Acanthometræ and Diatoms.

At Station 250, lat. 37° 49′ N., long. 166° 47′ W., the tow-nets attached to the trawl "which must have towed for a time at a depth of from 300 to 600 fathoms," contained Challengeridæ, Tuscaroridæ, and the like, which were not found in the tow-nets dragged within thirty fathoms of the surface.

At Station 251, lat. 37° 37′ N., long. 163° 26′ W., Velella was very abundant again. At Station 254, lat. 35° 13′ N., long. 154° 43′ W., a tow-net haul was made in 100 fathoms containing Challengeridæ. Murray again says, at Station 257, distant 402 miles from Oahu, lat. 27° 33′ N., a haul of the tow-net from 500 fathoms "brought up Globigerina, Orbulina, Pulvinulina, Phacodaria, and other Radiolariæ *not usually observed at the surface*" (the italics

are mine). At Station 259, in 2225 fathoms, 133 miles from Oahu, the tow-nets were sent down to 1000 fathoms, but it does not seem to me from the lists of the organisms brought up that they include any types not found near or at the surface elsewhere in less than 250 fathoms, and they were probably obtained in the upper belts.

The surface organisms of the line Hawaii to Tahiti are marked by the large number of species of surface Radiolarians collected specially at Stations 270, 271, in the line of the equatorial belt, and immediately north and south of it at Stations 268, lat. 7° 35′ N., 269, and 272–274, lat. 7° 25′ S. At Station 268 there were collected nearly sixty species of Radiolarians from the surface; at Station 269 about fifty species; at Station 270 the number of species of pelagic Radiolarians had increased to over eighty; and at Station 271 no less than 400 species of Radiolarians are recorded from the surface. At Station 272 the surface Radiolarians had decreased to about 120 species; at Station 273 to about seventy-five species; and at Station 274 the species had increased again to about 120 in number; and at Station 284, south of Tahiti, in nearly 30° south latitude, not more than seven species of Radiolarians were collected at the surface, about the same number which were collected at the surface at Station 262, in latitude 20° N., near Hawaii. At Station 263, lat. 17° 33′ N., long. 153° 36′ W., the surface Radiolarians had increased in number to nearly twenty species; at Station 265, lat. 12° 42′ N., long. 152° 01′ W., to nearly forty species, and at Station 267, lat. 9° 28′ N., long. 150° 49′ W., to fifty, the number of species gradually increasing towards the equatorial current belt.

As regards the other surface animals noted by the "Challenger," they consisted of Diatoms, Pyrocystis, Noctiluca, Globigerinæ, Orbulinæ, Pulvinulinæ, Diphyes, and other Medusæ, Siphonophores, Sagitta, Echinoderm larvæ, and Zoëa, near the Hawaiian Islands; Euphausia, Sergestes, Saphirina, Copepods, Amphipods, Phronimids, Hyperids, Oxyrhynchus, Pteropods, Appendiculariæ, Alciopa, Annelids and their larvæ, Tomopteris, Salpæ, Ianthinæ, young fishes, Sternoptyx, Scopelids, Cephalopods, Ctenophoræ, Halobates, Coccospheres, Rhabdospheres, Ostracods, Hyalea, Spirialis, Styliola, Tiedemannia, Stomatopods, Schizopods, Carinaria, Firoloides. These

genera occur, of course, in different combinations both in number of species and abundance of specimens at the stations occupied, but none of them were very marked types, or types which had not a wide geographical distribution in the tropical Pacific, as can be noted by comparing the above list with the notes of the contents of the surface hauls made by the "Albatross" in a nearly parallel line, but several hundred miles to the eastward.

As has been shown, p. 94, from the examination of the bottom deposits, a large number of pelagic Foraminifera were obtained by the "Challenger" on the line Tahiti to Valparaiso, as well as pelagic Radiolarians. Going south from Tahiti, the "Challenger" obtained three species of Radiolarians on the surface at Station 282, lat. 23° 46′ S., long. 149° 59′ W., seven at Station 284, lat. 28° 22′ S., long. 141° 22′ W., and no less than forty-two at Station 288, lat. 40° 03′ S., long. 132° 58′ W., the point at which the "Challenger" turned east toward Valparaiso, distant nearly 3000 miles. Along that line which runs somewhat north of the current setting east, in a somewhat higher latitude, the number of surface Radiolarians collected was quite remarkable. At Station 289, lat. 39° 41′ S., long. 131° 23′ W., seven species are enumerated, four from Station 290, lat. 39° 16′ S., long. 124° 07′ W., eighteen at Station 291, lat. 39° 13′ S., long. 118° 49′ W., the same number at Station 295, lat. 38° 07′ S., long. 94° 04′ W., and five at Station 297, lat. 37° 29′ S., long. 83° 07′ W.

The other surface organisms found by the "Challenger" going south from Tahiti to Station 288, in lat. 40° 03′ S., consisted of Pteropods, Diatoms, Hastigerinæ, Acanthometræ and other Radiolarians, Siphonophoræ, Ctenophoræ, Echinoderma larvæ, Sagitta, Cyprinida, Saphirina, Copepods,[1] Euphausia, Sergestes, Lucifer, Atlanta, Appendicularia, Scopelids, Halobates, Clio, Coccospheres, Rhabdospheres, Globigerinæ, Alciopa, Tomopteris, Salpæ, young Lamellibranchs, Phronimids, Hyperids, Stomapod larvæ, Thysanopoda, Benthocaris, Medusæ, Ostracods,[2] Amphipods, Schizopods, Doliolum, Scopelids.

On the line from Station 288 to Valparaiso the surface organisms, other

[1] The Copepods increased as the "Challenger" went south from Tahiti.

[2] The number of Ostracods at Station 296, lat. 38° 06′ S., long. 88° 02′ W., is very striking.

than the pelagic Foraminifera and Radiolaria, did not present any peculiar types; they were the usual pelagic types of the Pacific, such as: Siphonophores, Copepods, Amphipods, Pteropods, Cephalopods, Salpæ, Diatoms, Pelagia, Sagitta, Ostracods, Pelagic Annelids, Tomopteris, Hyperids, Sergestes, Euphausia, Lucifer, Atlanta, Appendicularia, Doliolum, Coccospheres, Rhabdospheres, Pulvinulina, Sergestes, Alciopa, Macrura, Scopelus, Ctenophoræ, Cyprinida, Phronima, Stomatopods, Ianthina, fish eggs, young fishes, Velella, Physalia, Ostracods, Macruran larvæ, Schizopods, Doliolum. This line is also characterized by the great number of Diatoms collected, and at Station 298 Sir John Murray says that "on the whole there was a great change in the general character of the surface fauna, pointing to the nearness of a great continent similar to what was observed off Japan and elsewhere."

The Bathymetrical Range of the Pelagic Fauna.

With regard to the bathymetrical range of the so-called intermediate fauna, the following notes are suggested by the records of the "Challenger" deep tow-net hauls in the Pacific.

At several of the stations the open tow-nets were hauled at a depth of 200 fathoms, and Challengeridæ and other Radiolarians not found at the surface were collected. It does not follow, because the tow-nets attached to the trawl and the weights brought up similar organisms to those obtained at 200 fathoms or more from the surface, that these types are found living all the way from the surface to the bottom, different species recurring at sundry bathymetrical ranges. The open nets attached to the trawl and weights contained, according to the lists given by Murray, only such genera as were also collected by nets sent down to less than 250 fathoms from the surface, and were probably caught by the trawl nets while passing through the upper strata. The experience of Hensen and of Chun has been like that of the earlier expeditions of the "Albatross," as well as the present one, that at the depth of 250 fathoms there is a very marked decrease in the number of organisms collected as compared with those living in a belt nearer the surface. It does not appear from the data given by Sir John Murray that there is any proof of the exist-

ence of the belts of bathymetrical range of pelagic organisms invented by Haeckel, based by him on data of the "Challenger." On the contrary, I would interpret the data of the "Challenger," as well as the results I have obtained in this and former expeditions, and those of the "National" and "Valdivia" Expedition, as showing that within a certain distance from the bottom, at sea, far from continental areas, there is a free-swimming fauna related to that found on the bottom; and that the pelagic fauna, so-called, away from the continents, where the surface fauna is a mixture of shore embryos and of pelagic animals derived from a comparatively short distance from the shore, extends to a very limited depth from the surface,—three hundred fathoms, or thereabout, indicating, from our present knowledge, the limit to which the so-called intermediate fauna extends; many of its members coming occasionally to the surface or near it, and the members of the surface fauna often dropping to considerable depths from disturbing atmospheric causes; near the surface these two faunæ thus become mixed to a certain extent. From my earlier observations, I was inclined to place the lower limit of bathymetrical range of the surface organisms somewhat too high, though even at that limit the pelagic fauna is already greatly reduced in numbers, as has been noticed also by subsequent observers.

Newport, R. I.
October 25, 1900.

REMARKS ON THE BOTTOM DEPOSITS (Plate 1a).

By Sir JOHN MURRAY, K.C.B.

Our knowledge of the deposits covering the floor of the tropical Pacific has been much increased by an examination of the soundings taken by the U.S.S. "Albatross" in 1899 and 1900, under the direction of Mr. Alexander Agassiz. It is true that no new type of deep-sea deposit has been discovered, but the distribution of the deposits has been considerably modified. The principal result, perhaps, is the enormous extension, towards the east, of the Radiolarian Ooze area discovered by the "Challenger" between 5° and 15° N. lat. and 145° and 155° W. long. Our examination of the samples recently collected, and of those collected in 1891, by the "Albatross," seems to show that this Radiolarian Ooze area extends uninterruptedly through about 85° of long. into the Gulf of Panama (where it occurs in comparatively shallow water), forming a band varying in width from 5 to 12 of lat. Another result is the eastern extension also of the Globigerina Ooze area at the equator, and the introduction of Pteropod Ooze around the coral islands of the Paumotu and Marquesas groups. The numerous soundings taken by the "Albatross" among the coral island-groups show that in many cases deep water, where the bottom is covered by Red Clay, approaches very close to the islands, but a curious circumstance regarding the samples collected in the vicinity of the coral islands is the large proportion of very small samples, from which all fine clayey and calcareous material has apparently been washed away during process of collection, so that it is often impossible to say, from the insufficient quantity of incoherent material at our disposal, what the precise condition of the deposit *in situ* may be. The "Albatross," like the "Challenger," crossed the typical Red or Chocolate Clay area, the trawl having, at Station 173 in lat. 18° 55′ S., long. 146° 32′ W., 2440 fathoms, brought up a large supply of stiff choco-

late clay, containing much Manganese in the form of larger and smaller nodules and small grains, and many sharks' teeth.[1]

A peculiar assortment of large continental rock fragments more or less impregnated and covered with Manganese was brought up by the trawl at Station 2, lat. 28° 23′ N., long. 126° 57′ W., 2368 fathoms, 450 miles from Guadalupe Island, the nearest land, where the deposit is an extremely pure Red Clay. These look like fragments transported by ice.

A comparison of this map with the map published in the "Challenger" Report on Deep-Sea Deposits in 1891 shows at a glance that a large mass of information bearing upon the distribution of marine deposits has been collected in the interval. From the numerous surveys made under the auspices of the British Admiralty in the S. W. Pacific, and northeastward to the Sandwich Islands and the American coast, in connection with the British cable between Australia and British Columbia, from the work of the "Albatross" and other ships of the U. S. Navy and U. S. Fish Commission, and from other sources, we have derived much information both regarding the depth and the deposits of the Pacific. The chief modifications on the deposit map of 1891 are,—

(1) The increased area occupied by the Radiolarian Ooze, in lat. 3° to 12° N., extending from long. 165° to 80° W., and also in lat. 8° S. to 6° N. and long. 162° to 177° W.

(2) The alterations in the form of the Globigerina Ooze areas, which are now, in the vicinity of the Coral Islands, more circumscribed, while the Red Clay is proportionally increased in area and more closely approaches the islands.

(3) The introduction of Pteropod Ooze in many localities not indicated on the earlier map; and

(4) The introduction of a band of Diatom Ooze in the extreme North Pacific Ocean, extending from off Yezo Island, Japan, hugging the Kurile and Aleutian Islands, to off Vancouver Island, British Columbia. The existence of this Diatom Ooze band was recognized during the examination

[1] It is rather surprising that no Cetacean bones are included in the material from this Station, indeed among the material sent to us for examination no Cetacean bones have been observed, although Mr. Agassiz mentions having obtained them at Stations 2 and 13.

recently of two series of deposit-samples, the one collected a quarter of a century ago by the U.S.S. "Tuscarora," the other collected in 1890 by the U.S.S. "Albatross," and it bears striking evidence to the bipolar distribution of the pelagic Diatoms whose frustules fall to the bottom in such numbers as to form continuous bands of Diatom Ooze on the seaward borders of the Blue Mud areas both in the far south and, on a smaller scale, in the far north.

EXPLANATION OF THE PLATES.

PLATE 1.

Track of the "Albatross" from San Francisco to Yokohama.

PLATE 1a.

Map of deposits of the Tropical Pacific. Prepared by Sir John Murray.

PLATE 1b.

Bathymetrical chart of the Central Pacific Ocean. Prepared by Sir John Murray.

PLATE 2.

Track of the "Albatross" from San Francisco to the edge of the Marquesas Plateau, showing the position of the "Moser" Basin. Stations 1 to 22.

PLATE 3.

Track of the "Albatross" through the Marquesas Islands. Stations 19 to 30.

PLATE 4.

Track of the "Albatross" from the Marquesas Islands to the Paumotu Archipelago (Ahe). Stations 29 to 34.

PLATE 5.

Track of the "Albatross" through the Paumotu Archipelago and the Society Islands. Stations 32 to 180.

PLATE 6.

Track of the "Albatross" from the Society Islands to Aitutaki (Cook Archipelago) and Niue, November 18 to 25, 1899. Stations 181 to 183.

PLATE 7.

Track of the "Albatross" from Niue to the Tonga Islands and Lau Group (Fiji). Stations 184 to 189.

PLATE 8.

Track of the "Albatross" through the Fiji Islands, December 6 to 20, 1899. Stations 189 to 193.

PLATE 9.

Track of the "Albatross" from the Fiji Islands, through the Ellice Islands, December 20–29, 1899. Stations 194 and 195.

PLATE 10.

Track of the "Albatross" through the Gilbert Islands, December 29, 1899, to January 7, 1900. Stations 196 to 208.

PLATE 11.

Track of the "Albatross" from the Gilbert Islands to Jaluit, through the Marshall Islands and to Kusaie and Ponape (Caroline Islands). Stations 208 to 240.

PLATE 12.

Track of the "Albatross" through the Carolines from Station 240 to Guam. Stations 240 to 249.

PLATE 13.

Track of the "Albatross" from Guam to Yokohama, February 25 to March 4, 1900. Stations 248 and 249.

PLATE 14.

1. Section across the "Moser" Basin from San Francisco Cal. to Nukuhiva, Marquesas Islands.
2. Section across the Marquesas Islands Plateau.

PLATE 15.

1. Section across the basin separating Nukuhiva (Marquesas Islands) to Rangiroa (Paumotus Islands).
2. Section across the channel separating Makatea (Paumotu Islands) from Tahiti (Society Islands).
3. Section from Makemo to Takume across Taenga and Raroia (Paumotu Islands).
4. Section from Anaa to Kauehi, across Fakarava (Paumotu Islands).
5. Section from Rangiroa to Matahiva across Tikehau (Paumotu Islands).
6. Section across Rangiroa (Paumotu Islands) from off Ahe.

PLATE 16.

1. Section across channel separating Plateau upon which are Niau and Apataki from Makatea. Paumotu Islands.
2. Section from Makemo and Hikueru across Ravahere Strait to Hao to Aki Aki and Plateau of Nukutavake and Pinaki.

PLATE 17.

Section across channels separating Plateau upon which are situated Tahanea, Tuanake, and Makemo from Anaa and from Takume (Paumotu Islands).

PLATE 18.

1. Section across channel separating Nukutipipi and Pinaki (Paumotu Islands).
2. Section along a line running about southeast from Tahiti to Mehetia to Hereheretue, Anu Anuraro, Anu Anurunga, and Nukutipipi.

PLATE 19.

Section from off Rota (Ladrone Islands) to Miaki, South of Cape King, Japan, showing the very irregular depth of the bottom in a line parallel to the volcanic islands of that region. From the soundings of the "Challenger" and of the U.S.S. "Nero." H. O. chart No. 529.

Figures of Manganese Nodules . . . . . to face page 5.

1. Station 13 Lat. 9° 57′ N., Long. 137° 47′ W.; 2690 fathoms.
2–4. " 173 " 18° 55′ S., " 146° 32′ W.; 2440 "
5–6. " 2 " 28° 23′ N., " 126° 57′ W.; 2368 "

All figures are natural size.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXVI. No. 2.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

II.

SOME SPECIES OF PARTULA FROM TAHITI.

A STUDY IN VARIATION.

By ALFRED GOLDSBOROUGH MAYER.

WITH ONE PLATE.

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CAMBRIDGE, U. S. A.:
Printed for the Museum.
January, 1902.

Reports on the Scientific Results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., commanding.

II.

SOME SPECIES OF PARTULA FROM TAHITI.

A STUDY IN VARIATION.

By ALFRED GOLDSBOROUGH MAYER.

(Published by permission of Geo. M. Bowers, U. S. Commissioner of Fish and Fisheries.)

The snails studied in this paper were collected in Tahiti by Dr. H. F. Moore, Ensign C. S. Kempff, U. S. N., and the author during two visits of the United States Fish Commission Steamer "Albatross" to the Island, from Sept. 27–Oct. 4, and from Nov. 6–13, 1899.

A great deal has been written concerning the classification of the species of Partula inhabiting the Islands of the Tropical Pacific. Unfortunately, however, the various species have been distinguished only by inspection of the color, form, etc., of the adult shells; and no attempt has been made to dissect the young out from the full-grown snails and thus determine, by direct evidence, whether or no the so-called "species" intergrade, and if so to what extent. There can be no doubt that if this method were pursued with all the known varieties and so-called "species" of such variable snails as Partula and Achatinella, the number of "species" would be much reduced; and above all our knowledge of the true relationships of the various forms would become established upon a more trustworthy basis than can be derived from decisions concerning merely the external resemblance or dissimilarity of the adult shells. A good example of the confusion which has crept into the synonymy of these species may be instanced in the case of Partula otaheitana (Figs. 3–8), where no less than nineteen specific names have been proposed for the various color varieties.

An extensive collection and a careful study of the Partulæ of Tahiti has been made by A. J. Garrett, Journ. Acad. Nat. Sci. Philadelphia, Ser. 2, 1884–95, pp. 43–81, Pls. II. and III. Garrett spent many years upon the Island, and his accounts of the distribution and relationships of the various forms is thus more accurate than are those of other authors who have not visited Tahiti. From him we learn that Partula hyalina (Figs. 1 and 2), although rare, is found everywhere in Tahiti, and it also inhabits the Austral Islands, and Mangaia, one of the Cook group. It nowhere gives rise to any varieties, and is the most widely distributed Partula known. Also, according to Garrett, Partula otaheitana (Figs. 3–8) has its headquarters in Fautaua ("Fautana") valley near Papeete, but is also found "all around the Island." I failed to discover it either in Maruapoo or Vaihiria valleys, and if it exists now in either of them it must be very rare. Partula filosa (Figs. 9, 10) is found only in Piræ (Pirai valley), while Partula sinistrorsa (Figs. 11–13) is found only on the south coast of "Tahiti, where it exists in profusion in the lowland forests for a distance of about ten miles." It is probable, however, that Garrett has confused some of the varieties of P. sinistrorsa with P. otaheitana. Garrett found the dextral P. nodosa restricted to a limited area about two miles up Punaauia valley on the west coast of Tahiti. I discovered a similarly colored *sinistral* snail in Maruapoo valley immediately south of, and adjacent to, Punaauia valley, and have no doubt that it is merely a sinistral, local, variety of P. nodosa (see Figs. 14, 15). Systematic descriptions of the Partulæ of Tahiti have been given by Pfeiffer, Pease, Reeve, Carpenter, and others. A complete citation of their works is given by W. D. Hartman: A catalogue of the genus Partula, West Chester, Pennsylvania, 1881, and also in Proc. Acad. Nat. Sci. Philadelphia, 1885, pp. 203–223.

The general topography and the names of the valleys in the neighborhood of Papeete is given in the British Admiralty Chart of the South Pacific, No. 1158, published July 22, 1895. A good general map of the Tahitian streams and valleys is given in "Karte der Insel Tahiti," J. A. Hecht, 1875.

As is well known the Island of Tahiti is figure 8-shaped, each half of the 8 being formed of a separate volcanic centre. The Island has been subjected to much erosion, and more than 140 deep trough-like valleys extend down-

ward from the high interior to the coast. The general trend of each of these valleys is perpendicular to the coast-line situated at its base, and thus it comes about that adjacent valleys are approximately parallel each to each, and separated from each other by a sharp-edged ridge. Many of the valleys are very broad at their bases near the sea-coast, but they all become narrow gorges in the interior of the Island. The sides of the valleys are steep, often 35°–60°, and in many places precipitous. The copious rain-fall on the upper slopes is sufficient to maintain a stream in almost every valley. The valley-bottoms are thus well watered and support a luxuriant growth of forest trees, such as the Tahitian chestnut (Inocarpus edulis), the "Purau" (Paritium tiliaceum), and others. The wild plantain, or "Fei" (Musa troglodytarum Linn.), Turmeric (Curcuma), and Dracæna grow in abundance in the moist earth of the valley-bottom, while the Caladium (Colocasia) clusters along the banks of the stream, and the ground under the trees is covered with a carpet of moss and ferns. This vegetation extends for a considerable distance up the sloping sides of the valley, and high up among the mountains the wild plantain and Dracæna often form a continuous forest crossing the ridges from valley to valley. Lower down, however, the ridges between the valleys are covered by a tangled mass of reeds and guava bushes, or are wholly barren of vegetation for long areas; and probably constitute a barrier over which it is impossible for snails to pass from valley to valley. Indeed the physical features of the Island, in so far as the nature of the valleys is concerned, are strikingly similar to the conditions found on the Island of Oahu of the Hawaiian Islands; and in Tahiti, as in Oahu, we find that the snails of each valley are possessed of marked and peculiar characters which distinguish them more or less from the snails of adjacent valleys.

It is evident that we have in Tahiti an opportunity to study the range of variability of the several, more or less isolated colonies of snails living in the different valleys, and to determine the relationships which may exist between the various forms.

Snails were collected in the following six valleys: Piræ, Hamuta, Fautaua, Tipaerui, Maruapoo, and Vaihiria. Piræ, Hamuta, Fautaua, and Tipærui valleys are approximately parallel each to each, and are situated on

the north side of the Island in the neighborhood of Papeete. Hamuta valley lies between Piræ and Fautaua, while Tipærui valley is situated to the westward of Fautaua and is separated from it by three ridges. The base of Piræ valley is about two miles east of Papeete, while the foot of Tipærui valley lies at the western end of the town, about three miles west of Piræ valley. Maruapoo valley is situated on the western side of the Island in the district of Punaauia, and is distant about eight miles from Papeete, while Vaihiria valley is upon the south side of the Island, twenty-seven miles from Papeete. Piræ, Fautaua, and Tipærui valleys are broad and well watered, and contain a luxuriant growth of wild plantains and Caladium, upon which the snails are found in large numbers. Hamuta valley is a deep, narrow trough lying between Piræ and Fautaua valleys. Few wild plantains are found within it, and the Caladium is not very abundant. Indeed the majority of the snails obtained in this valley were found upon the leaves and stems of Dracæna. Maruapoo valley is a narrow gorge with precipitous sides. There is but little wild plantain in the valley, and almost all of the snails were found upon the Caladium, which grows in abundance. Vaihiria valley is one of the largest and longest in Tahiti. A stream about ten yards wide and one in depth flows through the valley, and dense thickets of Turmeric extend for miles along its banks. The vegetation of this valley is very varied, all of the characteristic Tahitian trees and plants being represented in great numbers. The Caladium and the wild plantain grow here in abundance, but most of the snails were found upon the wild Turmeric, almost none being discovered upon the Caladium, and but few upon the leaves of the wild plantain.

In all of the valleys except Vaihiria the snails were found high up, very few of them being captured below 200 feet above sea-level, while above this point they grew more and more abundant as one ascended the valley-bottom. In Vaihiria valley, on the contrary, no snails were met with over 300 feet above sea-level, while they were found in considerable numbers from an altitude of 100 feet to near sea-level. It is remarkable that in Vaihiria valley, despite its luxuriant vegetation, and abundant supply of water, snails were much less common than in any of the other valleys which we explored.

The snails are probably nocturnal, for they were almost never found crawling during the day. With five exceptions they were all found upon the *under* sides of the leaves and stems of the plants they affect. They show a very decided preference for certain plants, and almost all of them were discovered upon the wild plantain and Caladium. In Hamuta valley, however, they were quite abundant upon Dracæna; and in Vaihiria the great majority of them were found upon the Turmeric. About half a dozen snails were found upon the stems of Guava (Psidium guaiava), "Purau" (Paritium tiliaceum), and upon various species of ferns.

It was my habit to spend the greater part of a day in each of the valleys and to take every snail which was seen.

As is well known, these snails are hermaphroditic and viviparous, and bring forth their young in an advanced state of development; and in order to facilitate the study of the relationships between the various forms, the young were dissected out from every adult containing them. The following table will show the number of snails captured in each valley, the number of adults which contained young snails, and the number of young which were dissected out from them. It will also show what might be termed the "ratio of fecundity," or the number of young for adult containing them.

Name of valley.	Date.	Total number of snails collected.	Number of snails containing young.	Number of young taken from the adults.	Number of young per adult.
	1899.				
Piræ . . .	Nov. 13	164	61	91	1.5
Hamuta . .	Oct. 2	127	64	127	2.0
Fautaua . .	Sept. 29[1]	47	27	43	1.6
" . .	Nov. 7	111	52	102	2.0
Tipærui . .	Sept. 28	124	72	130	1.8
Maruapoo .	Nov. 15	101	55	94	1.7
Vaihiria . .	Nov. 9	61	19	23	1.2
Total		735	350	610	Av. 1.7

We see from the above table that the snails differ both in abundance, and in their fecundity in the various valleys.

Certain general statements may, however, be made concerning the Partulæ of all six valleys. For example, the young of dextral or sinistral snails

[1] These snails were collected in about two hours instead of in six hours, as in other cases.

are usually dextral or sinistral respectively, but this is not invariably the case. It is interesting to observe, however, that *all* of the young developed within any given adult are either dextral or sinistral, never some of them dextral and others sinistral. The young are born one at a time; three eggs and two or three young snails in various stages of development being often found in a single adult animal. At the time of birth the shell of the young one comprises two and a half whorls. No young are developed until after the lip of the adult shell has been completely formed.

Partula hyalina Broderip.

Figs. 1, 2; 1ª–1ᶜ.

This snail is found in all six valleys, but is never abundant; constituting but 2½ per cent of the total number of snails in Piræ, 3 per cent in Hamuta, 12 per cent in Fautaua, 7 per cent in Tipærui, 1 per cent in Maruapoo, and 2 per cent in Vaihiria valley. It is readily distinguished from all the other snails by its milky-white, translucent shell, and the absence of a tooth upon the columella. Every individual found is dextral, as are also the young taken from the adults. In all forty-four specimens were obtained, and nineteen of these yielded fifty-five young snails. The young are all white in color, and show no tendency to intergrade with the young of any other species, hence we conclude that this is a true species separate and distinct from any other snail of the six valleys.

Partula otaheitana Bruguière.

Figs. 3–8.

Piræ, Hamuta, Fautaua, and Tipærui Valleys. The relationships of the color-types represented in Figs. 3, 4, 5, and 8.

These forms, which are represented in Figs. 3, 4, 5, and 8, are mere color varieties of one and the same species. They are found in Piræ, Hamuta, Fautaua, and Tipærui valleys, but appear not to exist in Maruapoo or Vaihiria. Fig. 3 represents the lightest colored type, where the entire shell is of a horny-yellow hue, while Fig. 4 represents the darkest type, the shell being of a uniform rich brown. In Fig. 5 we see a horny-

brown shell streaked longitudinally with darker brown, while Fig. 8 shows a light horny-brown shell having the apex tinged with pink. Many individuals which are intermediate in color between these various forms are found. An idea of the relative abundance of these color varieties in the different valleys may be obtained through an inspection of Table I. at the end of this paper.

Shells of the color-type represented in Fig. 3 are abundant in all of the four valleys, but are especially characteristic of Piræ, where they constitute 58 per cent of the entire number of snails found in the valley.

Fig. 4 is drawn from the darkest snail obtained in Tipærui valley. It contained two young which were much lighter in color than their parent, and resembled the young commonly found in snails of the type represented by Fig. 5.

Snails of the type of Fig. 5 are abundant in Hamuta, Fautaua, and Tipærui valleys, where they constitute 47, 62, and 53.5 per cent, respectively, of the shells found in each valley. In Piræ valley, however, they are not so abundant, constituting but 19 per cent of the snails found.

Fig. 8 represents a snail which resembles Fig. 3, excepting that the apex of the shell is tipped with pink.[1] It is remarkable that in Hamuta valley 63 per cent of the snails of the types shown in Figs. 3 and 5 are pink-tipped. In Piræ and Fautaua 9.5 per cent and 30 per cent respectively of these snails are pink-tipped, while in Tipærui valley none of them display this peculiarity. This as well as all the other evidence which we have collected concerning the biology of the Tahitian snails leads one to believe that the constitutions and inherited tendencies of the snails of any given valley are quite different from those of the snails of any other valley; for it would be difficult on any other grounds to account for the fact that the horny epidermis is readily disintegrated in Hamuta, while it resists weathering almost perfectly in Tipærui valley.

In Tipærui valley *all* of the snails represented in Figs. 3, 4, 5, and 8 are dextral, while in Piræ valley they are *all* sinistral. In the two intermediate valleys, Fautaua and Hamuta, however, the snails are some of them dextral, others sinistral. For example, in Fautaua valley 54 per cent

[1] This pink coloration is due to the partial disappearance of the outer epidermis of the shell.

are sinistral and 46 per cent dextral; while in Hamuta valley 69 per cent are sinistral and 31 per cent dextral. We see, then, that the snails gradually change from dextral to sinistral as we pass from Tipærui to Piræ valley.

Two hundred and eight snails of the type represented in Figs. 3 and 8 were collected in the four valleys, and 96 of them contained 150 young. 71 per cent of these young snails were of a light horny-yellow color very similar to that of the parent snail; 10 per cent, however, were slightly lighter than the parent, and 19 per cent were considerably darker in color than the shell from which they were dissected, and resembled the normal young obtained from snails represented by Fig. 5. Turning to the color-type represented in Fig. 5, we find that out of 255 individuals collected in Tipærui, Fautaua, Hamuta, and Piræ valleys, 119 contained 198 young. Of these young snails 55 per cent were very similar in color to the adults from which they were dissected, 40 per cent were lighter in color and resembled the normal young of the color type shown in Figs. 3 and 8, while 5 per cent were slightly darker than the parent shell. It is evident, therefore, that Figs. 3, 5, and 8 represent mere color sports of one and the same species of snail, for the young intergrade freely.

In Tipærui valley *all* of these young snails are dextral, while in Piræ they are all sinistral, exactly as are the adults in the respective valleys. In Fautaua valley, however, 54 per cent of the adults and 55.5 per cent of the young are sinistral; while in Hamuta, which lies between Fautaua and Piræ valleys, 69 per cent of the adults and 73 per cent of the young are sinistral. The small discrepancies between the percentages of sinistral adults and their sinistral young are probably due to aberrations of chance caused by the smallness of the number of snails observed, and would perhaps tend to disappear were a larger number to be studied.

It is interesting to observe that in Fautaua valley the dextral adults give 60 per cent dextral and 40 per cent sinistral young; while the sinistral adults of the same valley give 68 per cent sinistral and 32 per cent of dextral young. Also in Hamuta valley the dextral adults give 66.6 per cent dextral and 33.3 per cent sinistral young; while the sinistral adults give 95.5 per cent sinistral and 4.5 per cent dextral young. We see

that in both cases the sinistral snails breed truer to their type than do the dextral.

Partula otaheitana var. lignaria Garrett.

Figs. 6, 7.

The snail represented in Fig. 6 is found in Tipærui valley. The ground-color of the shell is quite similar to that of snails of color-type 5, but they are distinguished from the latter by the presence of a more or less distinct whorl-stripe, which extends from the suture of the spire through the middle of the body-whorl. In a few individuals there are two separate whorl-stripes, one through the middle of the body-whorl and the other adjacent to the suture. These snails constitute 26.5 per cent of the fauna of Tipærui valley. All of the specimens obtained were dextral, as were also the young dissected from them. Nineteen adults yielded thirty-three young, of which number twenty-eight were similar in ground-color to the type of snail shown in Fig. 5, while two were as light as the snails represented in Figs. 3 and 8, and three were slightly darker in color than the parent shells.

Of these young ones 41 per cent exhibit a distinct whorl-stripe, while 59 per cent are unstriped, and resemble in all respects the normal young of snails of type 5. Indeed among the sixty-one young taken from adults of type 5 in Tipærui valley, five exhibit the whorl-stripe characteristic of the young of type 6. There can be but little doubt, therefore, that in type 6 we have a race of snails which is derived from type 5, and which under conditions of more perfect isolation might in time develop into a distinct form. It is possible that this tendency may be prevented in Tipærui valley by constant intercrossing between the adults of types 5 and 6.

Fig. 7.

The sinistral snail with two whorl-stripes, which is represented in Fig. 7, is found in Hamuta and Pirae valleys, where they constitute 3 per cent and 4 per cent respectively of the snail-fauna. In Hamuta valley four adults yielded seven young, five of which were as light in ground-color

as the young of type 3 from the same valley, while two were slightly darker and resembled the ground-color of the young of type 5. Of these seven young, only one exhibited the whorl-stripe, the others being of a uniform ground-color. All of the adults were sinistral, while of the young three are dextral and four sinistral. There can be no doubt that type 7 of Hamuta valley is derived directly from snails of types 3, 5, and 8, of the same valley, and that together they form a race between the members of which no specific distinctions can be drawn. Snails of type 7 are also found in Piræ valley; unfortunately, however, only one young one was obtained from the five adults collected. This young snail possessed the ground-color of snails of type 5 with the addition of a very faint whorl-stripe.

Partula filosa Pfeiffer.

Figs. 9, 10.

This snail is found in Piræ valley. It may at once be distinguished from all other forms in this valley by its small size and the short blunt spire, also the outer surface is furrowed by deep longitudinal striæ, and the shells are all dextral. Thirty adults were collected, of which fourteen are dark brown in color and well represented by Fig. 9, while thirteen are light in color and resemble Fig. 10; and two others are intermediate in hue between Figs. 9 and 10. Ten adults of type 9 yielded twelve young, of which five were as light as type 10, while seven were similar to their parents in color. Eight adults of type 10 give eleven young, of which eight were about the same color as their parents, while three were darker and resembled type 9 in color. There can be no doubt, therefore, that Figs. 9 and 10 represent one and the same species of snail.

Summarizing the preceding observations, we find that there are but three species of Partulæ in Piræ, Hamuta, Fautaua, and Tipærui valleys. Two of these species, represented in Figs. 1, 2, and Figs. 3–8, respectively, are common to all four valleys; while the third, represented in Figs. 9 and 10, is found only in Piræ valley. The snail represented in Figs. 1 and 2 (P. hyalina Broderip) is found in scanty numbers in every valley in Tahiti which the author explored. It is a distinct species, and shows no tendency

to intergrade with any other forms, the young being always dextral in whorl, and of a white milky color very similar to the adult shell. Figs. 3–8 represent mere color varieties of one and the same species (P. otaheitana). Snails of the types of Figs. 3 and 5 are very common in all four valleys. Fig. 4 represents an extremely dark-brown individual found in Tipærui valley. No other individual was found which displayed this degree of melanic coloration, although many were found of a hue intermediate between Figs. 4 and 5. The pink-tipped snails illustrated in Fig. 8 are common in Hamuta valley, but are not very abundant in Fautaua or Piræ valleys, and were not discovered in Tipærui valley. Figs. 6 and 7 represent a peculiar color variety (P. otaheitana var. lignaria) which is evidently derived from the snails shown in Figs. 3, 4, 5, and 8; for some of the young taken from snails of the type of Figs. 6 and 7 resemble the normal young[1] of types 3, 4, 5, and 8, while some of the young of the latter exhibit the whorl-stripes characteristic of the normal young of Figs. 6 and 7. The snails of the type of Figs. 6 and 7 occur in the same valleys as their close relatives of the types of Figs. 3, 4, 5, and 8, and it is not improbable that their tendency to generate a whorl-striped variety is swamped by frequent inter-crossing with the unstriped snails of the same valleys. Were they isolated, it seems probable that they would soon initiate a new race, and in time perhaps a distinct species.

Partula hyalina, Figs. 1, 2. Partula nodosa var. *sinistralis, Figs. 14, 15. Maruapoo Valley.*

Maruapoo valley is situated on the western side of Tahiti, about seven miles south of Tipærui valley, from which it is separated by at least seven ridges. Of the two species of snails found in Maruapoo, only one is common to both Tipærui and Maruapoo. This one is the translucent milky-white species, P. hyalina, represented in Figs. 1 and 2. The predominant species of Maruapoo, P. nodosa Pfeiffer, var. sinistralis, is represented in Figs. 14 and 15, and constitutes 99 per cent of the snail-fauna of the valley. The shell is blunt in shape, and the spire is short. The lip is quite thick, and is usually

[1] The term "normal young" is applied to any young snail which is similar in color to the adult which bore it.

provided with a well-developed tooth upon the columellar side, and there is also a tooth upon the wall of the aperture. The surface of the shell is smooth and slightly polished, and there are no deep longitudinal furrows. About 57 per cent of these snails are well represented by Fig. 14. The ground-color is a light horny-yellow streaked longitudinally with darker brown, in addition to which there are two dark-brown whorl-stripes and a white whorl-stripe adjacent to the suture of the spire. In about 43 per cent the dark-brown whorl-stripes are either absent or very faint, and the ground-color of the shell varies from light horny-yellow to rich brown. A snail of this type is fairly well represented in Fig. 15, a dark-brown individual being drawn. Ninety-seven per cent of the adult snails of type 14 and 91 per cent of type 15 are sinistral; while of the young, 100 per cent from type 14 and 90 per cent from type 15 are sinistral. In the case of the snails of type 15, twenty-six sinistral adults gave forty-six sinistral and one dextral young; while two dextral adults gave four dextral and no sinistral young. Among the snails of type 14, only one of the dextral adults contained young, and this one gave a single sinistral offspring. Twenty-six whorl-striped adults of the type of Fig. 14 gave forty-two young, of which 76 per cent display whorl-stripes, while 24 per cent are plain colored. On the other hand, twenty-eight adults of type 15, which are either unstriped or with very faint whorl-stripes, gave fifty-one young, of which 61.5 per cent are marked with whorl-stripes and 38.5 per cent are plain colored. It is very evident that the striped and unstriped forms intergrade.

Of the one hundred adults found in the valley, 94 per cent are sinistral, while of the eighty-eight young taken from them, 94.5 per cent are sinistral. This condition appears, therefore, to be stable from one generation to another.

It will be observed that P. nodosa is somewhat like P. filosa (Figs. 9 and 10) from Pirac valley; it differs from the latter, however, in that there is a well-developed tooth upon the columellar lip, and the surface of the shell is polished and never furrowed, with dull-colored longitudinal grooves.

Partula hyalina, Figs. 1, 2. Partula sinistrorsa Pease, Figs. 11–13.
Vaihiria Valley.

Vaihiria valley is situated on the south side of the Island, about nineteen miles from Maruapoo, from which it is separated by about thirty ridges. There appear to be but two species of Partula in this valley, one of which is P. hyalina, represented in Figs. 1 and 2. The other species, P. sinistrorsa, represented in Figs. 11–13, constitutes 98 per cent of the snail fauna of the valley. These snails are very variable in color, and were it not for the fact that they all [1] give light yellow-white colored young they might readily be mistaken for several distinct species. Sixty-one per cent of the snails of this species belong to the type illustrated in Figs. 11 and 12, where the surface of the shell is smooth and polished and the ground color is of a light horny-yellow. Two broad whorl-bands of darker color traverse the body-whorl, and usually extend about the distance of another whorl up the spire of the shell. In about 95 per cent of these shells the whorl-stripes are of a rich dark-brown, as in Fig. 11, while in about 5 per cent they are faint in color, as in Fig. 12, or absent.

In about 8 per cent of the snails belonging to the predominant species of Vaihiria valley the ground color is of a light horny-yellow, very similar to the color of Fig. 3, while in about 16 per cent the ground-color is of a light horny-brown, streaked longitudinally with darker brown, giving very much the appearance of Fig. 5. Again, in about 10 per cent the shell is of a uniform rich dark-brown, similar in color to Fig. 4. Finally, in about 3 per cent of the snails the shell is parti-colored, the body-whorl being light horny-yellow, while the spire is rich brown, as in Fig. 13.

The snails of Vaihiria valley may be distinguished from those of similar color in Tipærui, Fautaua, Hamuta, and Piræ valleys by the following characters: In Vaihiria valley the snails lack a tooth upon the wall of the aperture, and the lip is relatively thin and fragile. The shell is also more constricted at the suture than is the case in the snails of the valleys near

[1] A single light-brown adult gave one light-brown young; all of the others gave light yellow-white colored young ones.

Papeete. Moreover, no matter what the color of the adult shell may be in Vaihiria, the young is light yellow, almost white.

All of the snails of the types represented by Figs. 11–13 are sinistral, as are also their young. Six snails of a uniform dark-brown color were found, and of these five were sinistral and one dextral. Among these, only one adult, a sinistral one, gave a single sinistral young.

Five light horny-yellow snails of uniform plain color were found, and all of these were dextral. Among them two adults gave rise to four dextral young. It is possible that these light-colored dextral snails may be considered specifically distinct from their darker associates, but as they give rise to young of the same color and general appearance as do the other snails of the valley, it seems probable that no specific distinction can be drawn.

Ten snails of a light horny-brown ground-color, streaked longitudinally with darker brown, were found. All were sinistral, and four of them gave six sinistral young.

Altogether, 90 per cent of the snails of Vaihiria valley are sinistral, as are also 90 per cent of the young dissected from them.

General Conclusions.

In Tahiti five species of Partula were found in the six valleys of Piræ, Hamuta, Fautaua, Tipærui, Maruapoo, and Vaihiria.

One species (P. hyalina Broderip), represented in Figs. 1 and 2, is rare everywhere, and yet it is found in all of the valleys. This is the only snail that is universally distributed. Another (P. otaheitana), shown in Figs. 3–8, is predominant in Piræ, Hamuta, Fautaua, and Tipærui, but is not found in the other valleys. The three other species are restricted each to a single valley. For example, the species shown in Figs. 9, 10 (P. filosa) is found only in Piræ valley, while the forms illustrated in Figs. 11–13 (P. sinistrorsa), and 14, 15 (P. nodosa var. sinistralis) are found, the former in Vaihiria and the latter in Maruapoo valley.

Partula hyalina, represented in Figs. 1 and 2, is very stable in all of the valleys, and gives rise to no varieties. All of the other species, however, are remarkably variable, and give rise to numerous color-sports.

These color-sports tend to breed true to themselves, and therefore to originate new color-forms and finally new species. This tendency is, however, held in check by frequent inter-crossing with the parent stock, and becomes effective only when the new color-variety is isolated, or when it displays a remarkably strong tendency to breed true. A good example of a color-variety that tends to breed true, but which is nevertheless held in check by frequent inter-crossing with the parent stock, is afforded by the type of snail represented in Fig. 6, which is derived from the type shown in Fig. 5, both coming from Tipærui valley. Here we find that 59 per cent of the young of Fig. 6 resemble the normal young of Fig. 5, while 8 per cent of the young of Fig. 5 exhibit the whorl-stripe characteristic of the young of Fig. 6.

It is probable that geographical isolation plays a most important part in the formation of new species. If two valleys be adjacent, their snails are closely related each to each, whereas the wider the separation between any two valleys, the more distant the relationship between their snails. The ridges between the valleys, being either barren or covered with vegetation unsuitable to the snails, afford barriers over which the animals must find it more or less difficult to pass. Thus the Partulæ in the Tahitian valleys are isolated very much as are the Achatinellidæ of Oahu in the Hawaiian Islands.

In Tahiti the snails are most abundant in the valley-bottoms, where they usually occur on the under sides of the leaves of Caladium and Plantain, although in some valleys they are frequently found on Dracæna and Turmeric. Although more abundant in the bottom, they extend for some distance up the sides of the valley and appear to be present in most places where the plants which they affect are found. As far as the very limited observation of the writer goes, there appears to be no difference in the character of the snails in different parts of the same valley. The difference between any two adjacent valleys is, however, very marked.

All of the snails of Tipærui valley are dextral, while all of the same species in Piræ valley are sinistral. In the two intermediate valleys of Hamuta and Fautaua some individuals are dextral and some sinistral.

TABLE I.

SHOWING THE ACTUAL NUMBER OF SNAILS COLLECTED, AND THE PERCENTAGE OF EACH COLOR-TYPE IN THE SNAIL-FAUNA OF EACH VALLEY. THE GREATER NUMBER OF THESE COLOR-TYPES ARE FIGURED ON THE PLATE.

Name or description of snail.	Number and percentage of each color-type of snail in each valley.											
	Piræ Valley.		Hamuta Valley.		Fautaua Valley.		Tipærui Valley.		Maruapoo Valley.		Vaihiria Valley.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Partula hyalina Figs. 1, 2 . .	4	2.5	4	3	20	12	9	7	1	1	1	2
Partula otaheitana { Figs. 3, 8	95	58	58	46	40	26	15	12	. .	. .	. .	. .
Partula otaheitana { Fig. 4	. .	. .	. .	. .	. .	. .	1	1	. .	. .	. .	. .
Partula otaheitana { " 5	31	19	60	47	98	62	66	53.5	. .	. .	. .	. .
Partula otaheitana var. lignaria { " 6	. .	. .	. .	. .	. .	. .	33	26.5	. .	. .	. .	. .
Partula otaheitana var. lignaria { " 7	5	3	5	4	. .	. .	. .	. .	. .	. .	. .	. .
Partula filosa { " 9	14	8.5	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Partula filosa { " 10	15	9	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Partula sinistrorsa { " 11	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	35	58
Partula sinistrorsa { " 12	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	2	3
Partula sinistrorsa { " 13	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	2	3
Partula nodosa var. sinistralis { " 14	. .	. .	. .	. .	. .	. .	. .	. .	57	56.5	. .	. .
Partula nodosa var. sinistralis { " 15	. .	. .	. .	. .	. .	. .	. .	. .	43	42.5	. .	. .
Plain colored light horny-yellow	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	5	8
Plain colored dark brown . .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	6	10
Light horny-yellow with longitudinal brown streaks . . .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	10	16
	164	100	127	100	158	100	124	100	101	100	61	100

TABLE II.

SHOWING THE NUMBER, COLOR, AND CHARACTER OF WHORL OF YOUNG SNAILS DISSECTED OUT FROM ADULTS OF P. OTAHEITANA OF THE TYPE SHOWN IN FIGS. 3, 8.

Valley.	Number and character of adults from which young were obtained.	Number of young which are slightly lighter than the parent shell.	Number of young which are similar in color to the parent shell.	Number of young which are darker than the parent shell, and resemble the normal young of snails shown in Fig. 5.	Number of dextral young.	Number of sinistral young.
Tipærui . .	9 D	1	8	3	12	0
Fautaua . .	9 D	2	10	3	10	5
"	16 S	5	17	7	20	9
Hamuta . .	22 S	2	17	14	2	31
"	10 D	3	10	1	8	6
Piræ . . .	30 S	2	44	1	0	47
	96	15	106	29	52	98
		10%	71%	19%		
		150				

D indicates that the shell is dextral in whorl ; S, sinistral.

TABLE III.

SHOWING THE NUMBER, COLOR, AND CHARACTER OF WHORL OF YOUNG SNAILS DISSECTED OUT FROM ADULTS OF P. OTAHEITANA OF THE COLOR-TYPE SHOWN IN FIG. 5.

Name of valley.	Number and character of adults from which young were obtained.	Number of young which are lighter in color than the parent shell, and resemble the normal young of snails shown in Fig. 3.	Number of young which are similar in color to the parent shell.	Number of young which are darker than the parent shell.	Number of dextral young.	Number of sinistral young.
Tipærui . .	37 D	21	36	4	61	0
Fautaua . .	21 D	12	23	0	20	15
" . .	22 S	14	19	3	1	35
Hamuta . .	8 D	3	10	0	10	3
" . .	21 S	21	14	3	1	37
Piræ . . .	10 S	9	6	0	0	15
	119	80	108	10	93	105
		40%	55%	5%		
		198				

D indicates that the whorl of the shell is dextral; S, sinistral.

EXPLANATION OF THE PLATE.

Five species of snails are represented on the Plate; as follows: Figs. 1, 2. *Partula hyalina* Broderip; Figs. 3–8. *Partula otaheitana* Bruguière; Figs. 9, 10. *Partula filosa* Pfeiffer; Figs. 11–13. *Partula sinistrorsa* Pease; Figs. 14, 15. *Partula nodosa* var. *sinistralis* Pfeiffer = *P. trilineata* Pease.

Figs. 1–15 represent adult or nearly full-grown snails, while Figs. 1^a–3^a, etc., show young snails taken from adults of corresponding number. Thus: 3^a is a young one taken from the type of snail represented in Fig. 3, etc. These Figures of young snails are four times the natural size, while the Figures of adults are one and a half times the natural size.

Figs. 1, 2. *Partula hyalina.* — From a snail obtained in Tipærui valley near Papeete. This species is found in all of the valleys of Tahiti, but is never abundant anywhere.

Figs. 3–8. *Partula otaheitana.* — These Figures show various common color-varieties of one and the same species of snail. Figs. 3–6 are taken from snails of Tipærui valley; Fig. 7, from Piræ; and Fig. 8, from Hamuta valley.

Fig. 6 represents a color-variety derived from the form shown in Fig. 5; while Fig. 8 is similarly derived from Fig. 3. All of these snails are dextral in Tipærui, and sinistral in Piræ valley; while in the two intermediate valleys of Fautaua and Hamuta some individuals are dextral and others are sinistral. In Hamuta valley the apex of the shell is often tinged with red-brown, or pink, as in Fig. 8. This is due to the wearing away of the outer epidermis of the shell.

Figs. 9, 10. *Partula filosa.* — A species obtained in Piræ valley.

Figs. 11–13. *Partula sinistrorsa.* — Color-varieties of a species of snail obtained in Vaihiria valley.

Figs. 14, 15. *Partula nodosa* var. *sinistralis.* — Color-varieties of a form obtained only in Maruapoo valley.

Figs. 1ª, 1ᵇ, 1ᶜ. *Partula hyalina.* Young of the snail shown in Figs. 1 and 2.

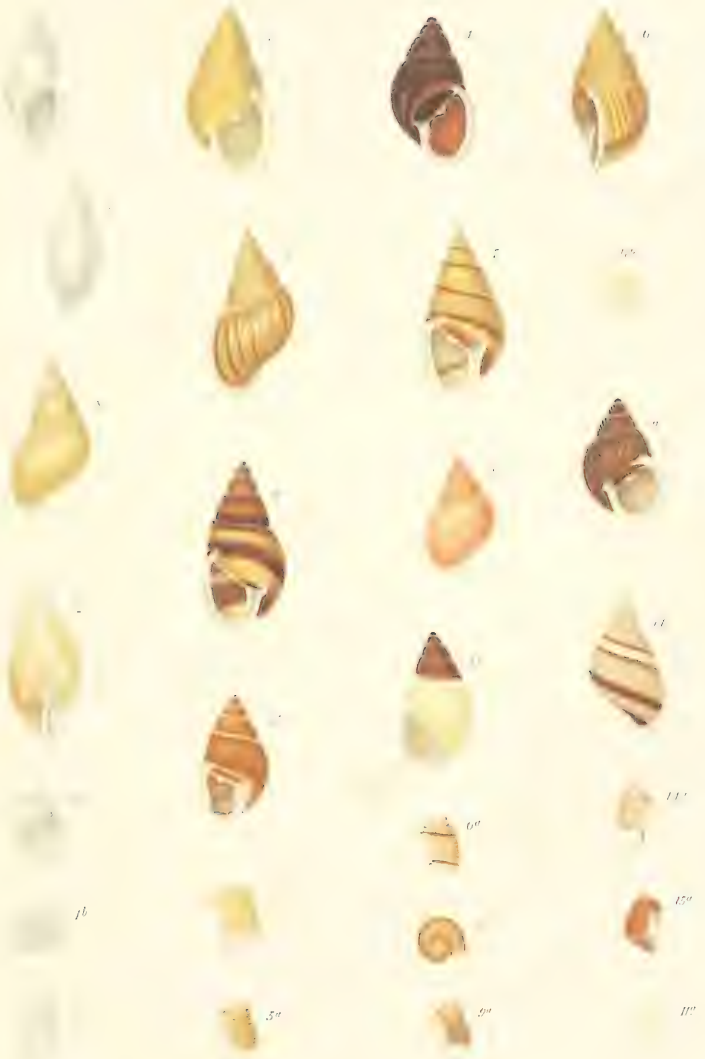
Figs. 3ª, 5ª. *Partula otaheitana.* Young of the snails represented in Figs. 3 and 5. Many of the young of Fig. 3 resemble 5ª, while very often the young of Fig. 5 resemble 3ª. Snails of the color type shown in Figs. 4, 6, 7, and 8 often give young of the types represented in Figs. 3ª and 5ª.

Figs. 6ª, 6ᵇ. *Partula otaheitana* var. *lignaria.* Young of the snail shown in Fig. 8. Similarly colored young are often given by the snail shown in Fig. 7. Very often the young of Figs. 6 and 7 resemble Figs. 3ª and 5ª.

Fig. 9ª. *Partula filosa.* Young of the snails shown in Figs. 9, 10. This is a young one of a medium hue, some being darker and others lighter in color.

Figs. 11ª, 11ᵇ. *Partula sinistrorsa.* Young of the snails represented in Figs. 11–13.

Figs. 14ª, 15ª. *Partula nodosa* var. *sinistralis.* Young of the snails shown in Figs. 14 and 15. Some of the young of Fig. 14 resemble 15ª, while some of the young of Fig. 15 resemble 14ª. Some of the young are plain colored, while others exhibit distinct whorl-stripes as in 14ª.


1
4
5
7
11
11'
6''
12''
1b
5''
9''
11''

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXVI. No. 3.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

III.

MEDUSÆ.

BY

ALEXANDER AGASSIZ AND ALFRED GOLDSBOROUGH MAYER.

WITH THIRTEEN PLATES, AND A CHART OF THE ROUTE.

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CAMBRIDGE, U. S. A.:
Printed for the Museum.
January, 1902.

Reports on the Scientific Results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., commanding.

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INTRODUCTION.

The medusæ described in the following paper were obtained in thirty-four surface hauls, and in one bottom trawl made at 830 fathoms in the Marquesas. In addition to these there were thirteen intermediate hauls with an open net, one at 100 fathoms, five at 150 fathoms, and seven between 250–350 fathoms and the surface.

The hauls in which medusæ were captured were distributed as follows:—

	Surface.	Intermediate.	Bottom trawl.
Between San Francisco, Cal., and the Marquesas . .	11	4	. . .
Among the Marquesas, Paumotus, and Society Islands	17	8	1
After leaving the Society Islands	6	1	. . .
Total	34	13	1

We were unable to make many hauls after leaving the Society Islands, and it is therefore impossible for us to draw any accurate conclusions concerning the relative abundance of pelagic life in the eastern and western regions of the tropical belt of the Pacific. It is worthy of note, however, that while our tows among the Paumotus and Society Islands were very poor, and almost no pelagic life was to be seen, as soon as we entered the

region of the Japan current north of the Ladrones the water teemed with life, and the display of phosphorescence at night was truly remarkable. In fact it is evident that pelagic animals are not abundant in regions far from large land masses or where there are no well defined oceanic currents or counter currents. As soon as one approaches the region of great currents or counter currents, or the coasts of continents and larger islands, the number of animals increases with remarkable suddenness.

It was very noticeable that during the daylight hours our surface tows were generally deficient in animal life, while those made at the same time with an open net at depths varying between 300 fathoms and the surface were remarkably rich both in number and variety of the specimens obtained. It is evident that in the regions we examined the pelagic animals sink to an unknown depth during the daytime. It should also be noted that these same animals rise to the surface during the night, for our surface hauls made at night were almost without exception much more successful than those made in the same locality during the day.

Among the twenty Hydromedusæ obtained by the "Albatross," seven are Trachylina and thirteen Leptolina forms. The relatively great number of the Trachylina forms is quite striking, for these medusæ are rare in waters adjacent to the coasts of continents. In the open sea, however, they constituted the greater number of the pelagic types. Our hauls in the free expanse of ocean between California and the Marquesas were wonderfully rich in such Trachylina forms as Rhopolonema, Aglaura, and Liriope, while Æginа and Solmaris were met with occasionally. Almost all of the Leptolina forms were captured near some coast or among the islands of an archipelago. There were, however, two remarkable exceptions to this rule: A young Sarsia was obtained in N. Lat. 9° 45′, W. Long. 137° 47′, where the nearest land (the Marquesas) was more than 1000 miles away; and a Tiara was found 600 miles north of the Marquesas. In general, however, the results support the conclusions of Maas,[1] in the case of the Plankton Expedition, that Leptolina forms are creatures of the shallower waters near coasts, while the Trachylina are animals of the open ocean.

[1] Maas, O., 1893; Craspedoten Medusen der Plankton-Expedition. Also On some Problems of the Distribution of Marine Animals, Natural Science, London, Vol. II., p. 92–99.

The following table will serve to show the extent of our captures: —

	Number of Species obtained.	Number of Species new to Science.	Number of Species already known.
Hydromedusæ	20	11	9
Scyphomedusæ	8	4	4
Siphonophoræ	10	4	6
Ctenophoræ	4	2	2
	42	21	21

The following forms are represented in both the Tropical Pacific and Atlantic by identical or very closely allied species: Aglaura prismatica, Liriope hyalina, Nausithoë punctata var. pacifica, Abyla quincunx, Nectophysa Wyvillei?

DESCRIPTION OF THE SPECIES.

HYDROMEDUSÆ.

Sarsia sp.

A single specimen of a young Sarsia in a greatly damaged condition was found on the surface when the nearest land (the Marquesas Islands) was over 1000 miles away. It is remarkable that this Leptolina form should have been taken so far out upon the open ocean.

S^{d};[1] Station 13; September 5, 1899; N. Lat. 9° 57′, W. Long. 137° 47′.

Tiara oceanica, sp. nov.

Plate 1, fig. 1.

The bell is acorn-shaped and 5 mm. in height. The walls are very thin, and there is a small, solid, apical projection. There are eight long, eight medium size, and sixteen short tentacles. The long ones are about as great in extent as the bell height. The medium tentacles are about one-third as

[1] S^{d} indicates a surface tow made in the daytime; S^{n} a surface tow made at night; $(150\,f - S)^{d}$ indicates a haul made with an open net dragged between 150 fathoms and the surface during the day; $(150\,f - S)^{n}$ indicates the same made at night.

long, and the small ones are mere rudiments. All of the tentacles arise from the bell-margin. The basal bulbs of the long and intermediate ones are conical, and each one bears a single ocellus upon its aboral side near the base. The velum is well developed. There are four narrow radial tubes, the mid-regions of which display jagged edges. The proboscis is bound to the radial canals by means of four mesenteries. The proboscis is short and extends only about one-half of the distance from the inner apex to the velum. The gonads occupy four radially situated linear swellings, the surfaces of which are complexly folded. The four lips are large and are much folded. The proboscis and tentacle bulbs are of a delicate purple-pink and the ocelli are dark red. A single specimen was found about 600 miles north of the Marquesas.

(250 f — S)^{d}; Station 16; September 9, 1899; N. Lat. 2° 38′, W. Long. 137° 22′.

Turris pelagica, sp. nov.

Plate 1, fig. 2.

The bell is 16 mm. in height, and the sides are barrel-shaped, being wider at the middle than at either end. There is a small, solid, apical projection. The bell walls are very thin and quite flexible. There are about thirty short tentacles, all being of the same size. These tentacles all arise from the bell-margin, and their bases are large and conical. There are no ocelli. The velum is well developed. There are four radial tubes which are flat and quite broad, being narrower near the circular canal than at any other place. Their outer edges are jagged, excepting in the narrow parts near the circular canal. The proboscis is large and fills the greater part of the bell-cavity. It is bound to the four radial canals by means of four mesenteries. The gonads occupy four radially situated double rows which extend about two-thirds of the distance from the inner apex of the bell-cavity to the velar opening. The outer surfaces of the gonads are transversely folded and give rise to numerous papillæ. There are four well developed, complexly crenulated lips. The lips and tentacle bulbs are of a light port-wine color, and the gonads and radial canals are of a still lighter shade. A single specimen of this medusa was found in a surface haul.

S^{d}; Station 1; August 26; N. Lat. 31° 10′, W. Long. 125°.

PSYTHIA, gen. nov.

Williadæ with four simple unbranched radial canals.

In all previously known genera of the family Williadæ the radial canals are branched. The general form, color, shape of proboscis, and method of budding of the present medusa, however, all incline one to place it among the Williadæ. It may be a primitive, or ancestral, form in which the canals have remained simple, or possibly an atavistic sport from some of the more complex Williadæ, or an immature individual which may give rise to medusa-buds before attaining its complete development.

Psythia prolifera, sp. nov.

Plate 1, fig. 3.

In the single specimen obtained, the bell was much shrivelled by contraction, so that its exact shape could not be ascertained. It appeared, however, to be slightly flatter than a hemisphere, and 4 mm. in diameter. The gelatinous substance was of uniform and only moderate thickness. There were four stiff, radially situated tentacles, each of which was about one-half as long as the bell-height. The entoderm of these tentacles was composed of chordate cells, and a very fine axial canal appeared to extend throughout the length of each tentacle. There were four straight, simple, radial canals; and a simple, slender, circular canal. The proboscis was cruciform in cross-section, and about three-quarters as long as the height of the bell-cavity. The four lips were small and slightly recurved. Four medusa-bearing stolons arose from the four radial corners of the stomach very near the points of entrance of the four radial canals. Each of these stolons gave rise to from two to six medusa-buds in various stages of development. When about to be set free the young medusa possesses four simple tentacles and radial canals, as in the adult; but its proboscis shows no trace of the proliferating stolons. The ex-umbrella of the young medusa is sprinkled over with nematocyst cells. The entoderm of the proboscis and stolons is ochre-yellow, all other parts being colorless. A single specimen

of this medusa was obtained, in an open net towed between 300 fathoms and the surface, off Marokau Island, Paumotus Group.

(300 f — S)[d]; Station 136; October 28, 1899; S. Lat. 18° 08′, W. Long. 141° 49′.

Lymnorea ocellata, sp. nov.

Plate 2, figs. 9–12.

The top of the bell is flat and the sides flare outward in a bell-shaped manner. The animal is about 4 mm. in diameter, and is about as high as it is broad. The bell-walls are thin, and quite flexible. There are about fifty short stiff tentacles which are each about one-half the length of the bell-height. These tentacles are usually carried curled upward, and their entodermal cores are solid and composed of vacuolated chordate cells. The basal bulbs of the tentacles are large, and each one contains a mass of red pigment. In addition to this there is a prominent ectodermal ocellus upon the ventral (lower) side of each tentacle at a short distance centrifugally from the basal bulb. The velum is small. There are four straight, narrow radial canals and a slender circular tube. The peduncle of the proboscis is wide and quadratic in cross-section, and its lower portion, near the gastric region, consists of highly vacuolated entodermal cells. The gastric part of the proboscis is pear-shaped, and the mouth is a simple round opening. The entire proboscis extends about one-half the distance from the inner apex of the bell-cavity to the level of the velar opening. There are four well developed oral tentacles, each one of which is about half as long as the height of the proboscis. Each oral tentacle branches dendritically four times, thus giving rise to sixteen distal knobs. Each knob is thickly covered with a bristling cluster of fusiform nematocyst cells. In addition to these there are several patches of nematocystic bristles upon the sides of the main trunk of each oral tentacle. The gonads are developed in four radial regions within the gastric part of the proboscis. The entoderm of the tentacle bulbs and of the gastric part of the proboscis is brick-red. The ectodermal ocelli are black. A number of these medusæ were obtained on the surface in the lagoon of Makemo Island, Paumotus, on October 23, 1899.

Bougainvillia fulva Agassiz and Mayer.

Bougainvillia fulva Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 162, Pl. 2, Fig. 6.

Plate 2, fig. 8.

An immature individual of this species was found by us among the Fiji Islands in 1898, and a mature specimen was obtained off Funafuti Atoll, Ellice Islands, on December 22, 1899.

The bell is about 6 mm. in height and the sides are straight and vertical. The gelatinous substance is of uniform thickness everywhere. There are four bunches, each containing seven tentacles, which arise from the bases of the four radial canals. These tentacles are solid and their entodermal cells are chordate. A single dark-colored ocellus is situated upon the under or centripetal side of each tentacle near the basal bulb. The velum is narrow. There are four straight, narrow, radial canals and a slender circular vessel. The proboscis is quadratic, and its base is wide. It extends about one-third of the distance from the inner apex of the bell-cavity to the velar opening. Four oral tentacles, each of which branches dichotomously four times, arise from the four radial corners of the proboscis near the mouth. The mouth is a simple round opening. The gonads are situated in the proboscis. The entoderm of the proboscis and tentacle bulbs is rosin-yellow. The tentacles are of a translucent milky color, and the bell is transparent. A single specimen was obtained in an open net towed from a depth of 150 fathoms to the surface.

(150 f — S)'; Station 195; December 22, 1899; S. Lat. 10° 47', W. Long. 179° 30'.

Epenthesis rangiroæ, sp. nov.

Plate 1, fig. 4.

The bell is slightly flatter than a hemisphere, and is 7 mm. in diameter. The bell-walls are thin and flexible. There are sixteen well developed tentacles with large conical basal bulbs. Sixteen otocysts, each containing a single spherical otolith, alternate in position with the sixteen tentacles. The velum is broad. There are four straight, slender, radial canals, and a narrow circular vessel. The proboscis is very short and quadratic in cross-

section, and there are four slightly recurved lips. The four gonads are found upon the four radial canals very near to the circular vessel. In the single specimen obtained, each gonad contained from six to eight prominent eggs. The medusa is transparent with the exception of the proboscis gonads and tentacle bulbs, which are translucent and milky in color. This form was found in the lagoon of Rangiroa Island, Paumotus, on September 23, 1899.

(150 f — S)[4]; Station 195; December 22, 1899; S. Lat. 10° 47′, W. Long. 179° 30′.

Phortis elliceana, sp. nov.

Plate 2, figs. 5–7.

The bell is much flatter than a hemisphere, and is about 16 mm. in diameter. The gelatinous substance is thick at the aboral pole, but becomes thinner towards the bell-margin, which is sharp-edged. There are about fifty-six hollow tentacle bulbs. Four of these are large, and are situated at the bases of the four radial canals. Twelve others are of medium size, and three of these are found in each quadrant. In addition to these there are about forty very small rudimentary tentacle bulbs upon the bell-margin. There are no lateral or marginal cirri. There are about fifty-six otocysts which alternate in position with the tentacle bulbs. Each otocyst contains two or three spherical otoliths. The velum is well developed. There are four simple, narrow, radial canals, and a slender circular vessel. The peduncle is about as long as the bell-diameter, and projects a considerable distance beyond the bell-opening. The basal part of the peduncle has the shape of a four-sided truncated pyramid, while the distal portion is long, and tapers gradually toward the gastric part of the proboscis. The four radial canals extend down the angles of the peduncle to the gastric portion of the proboscis. The latter is short and flaring, and there are four well developed, recurved, crenulated lips. The gonads are linear, and are developed upon the sub-umbrella regions of the radial canals. The entoderm of the tentacle bulbs and gonads is pink in color, while that of the gastric portion of the proboscis is rosin-yellow. A single specimen of this medusa was found in an open net which was towed from a depth of 150 fathoms to the surface, off Funafuti Atoll in the Ellice Islands.

(150 f — S)[4]; Station 195; December 22, 1899; S. Lat. 10° 47′, W. Long. 179° 30′.

Rhegmatodes lacteus, sp. nov.

Plate 3, figs. 15, 16.

The bell is flatter than a hemisphere, and is 50 mm. in diameter. The gelatinous substance is thick at the apex, but thin at the bell-margin. A long funnel-shaped depression, at the apex of the bell, extends downward almost to the level of the stomach. There are ten well developed tentacles, each of which is about one-tenth as long as the bell-diameter. These tentacles are provided with large hollow, bulbular bases. In addition to these large tentacles there are about 250 very small rudimentary ones. There are about 500 otocysts, each containing two small spherical otoliths. The velum is delicate and narrow. There are 105 straight, narrow radial canals, upon the middle and lower regions of which the gonads are developed. The stomach is 25 mm. in diameter, and the canals arise from its periphery. The proboscis is short, and there are 105 simple lips. The tentacles, proboscis, and genital organs are of a translucent milky color. A single specimen was found in a surface haul a few miles north of Tahiti.

Station 73; October 5, 1899; S. Lat. 17° 27′, W. Long. 149° 32′.

Mesonema macrodactylum Brandt.

Mesonema macrodactylum Brandt, J. F., 1838; Mem. Acad. Imp. St. Petersbourg, Sci. Nat. Ser. 6, Tom. IV., p. 359, Taf. IV.

Large numbers of this medusa were found swimming at the surface in the lagoon of Likieb Atoll, Marshall Islands, on January 20–21, 1900. The tentacles are not quite so long as in Brandt's figures. The entoderm of the canals, tentacle bulbs, and lips is slightly milky in color; all other parts of the medusa being colorless. Brandt describes this species from the tropical Pacific, and Chun (1896; Mitt. Nat. Mus. Hamburg, Jahrg. 13, p. 7) records it from the coast of Zanzibar.

Polycanna purpurostoma Agassiz and Mayer.

Polycanna purpurostoma Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 169, Pl. 8, Figs. 26–28.

A single specimen of this medusa, 50 mm. in diameter, was obtained in a surface tow made off Tahaa Island, Society Islands, on November 16, 1899. We found it among the Fiji Islands in December, 1897.

Liriope hyalina Agassiz and Mayer.

Liriope hyalina Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 166, Pl. 9, Fig. 32.

Specimens of this medusa were found by the "Albatross" in the Marquesas, Paumotus, Society, Ellice, and Marshall Islands; and they were especially common in the tropical part of the open ocean between California and the Marquesas. We found this species in the Fiji Islands in 1897–98.

	S^{l};	Station 13;	September 5, 1899;	N. Lat. 9° 57′,	W. Long 137° 47′.
	S^{d};	" 14;	" 7, "	" 6° 41′,	" 137°.
	S^{n};	" 16;	" 9, "	" 2° 38′,	" 137° 22′.
(300 f—S)^{n},	S^{a};	" 25;	" 14, "	Between Ua Huka and Marchand Islands, Marquesas.	
	S^{n};	" 31;	" 19;	S. Lat. 12° 20′, W. Long. 144° 15′.	
	S^{n};	——	October 22;	Lagoon of Makemo Island, Paumotus.	
(100 f—S)^{d};	Station 173;		November 4;	S. Lat. 18° 55′, W. Long. 146° 32′.	
	S^{a};	——	" 17;	off Bora Bora Island, Society Islands.	
(150 f—S)^{l};	Station 195;		December 22;	S. Lat. 10° 47′, W. Long. 179° 30′.	
	S^{a};	——	" 25;	Lagoon of Funafuti, Ellice Islands.	
	S^{a};	——	January 20, 1900;	Lagoon of Likieb Island, Marshall Islands.	

Dipleurosoma pacifica, sp. nov.

Plate 3, figs. 13, 14.

The bell is very flat, being about three times as broad as it is high, and 23 mm. in diameter. The surface of the ex-umbrella is reticulated by a regular system of hexagonal elevations bounded by shallow furrows. There are about one hundred short tentacles with narrow bulbular bases. The entodermal core of these tentacles is solid and composed of chordate cells. At the bases of most of the tentacles, upon the lower side, there is a single black ocellus. Slender club-shaped sensory bodies are scattered at frequent and irregular intervals between the tentacles. The entodermal core of these bodies is solid, and very similar to that of the tentacles. There are no otoliths. The velum is narrow. Six radial canals arise in groups of three from diametrically opposite sides of the stomach. In the single specimen examined two of these canals bifurcate, and thus eight canals reach the circular vessel. The gonads are linear and occupy the middle region of the eight canals. Their surfaces are slightly papillate, and the ova stand out as hemispherical protuberances. The stomach is elongated in the direction of the two opposed groups of radial canals. The proboscis is

very short, and there are six small, slightly crenulated lips. The tentacle bulbs, genital organs, and proboscis are milky white, all other parts of the medusa being transparent. A single specimen was obtained in a surface haul about fifty miles north of Tahiti.

Geryones mexicana, sp. nov.

Plate 4, fig. 17.

The bell is broad and pear-shaped and is about 5 mm. in diameter. The gelatinous substance is very thick at the aboral pole, but becomes thin near the bell-margin. There are six large, hollow, interradial tentacles, the centrifugal sides of which are provided with wart-like nematocyst-bearing swellings. There are also six slender, solid radial tentacles, each of which arises from the side of the bell at a short distance above the margin. There are six otocysts which are situated near the bases of the six interradial tentacles. Each otocyst contains a single spherical otolith. The velum is well developed. There are six straight radial canals which are wider near the proboscis than they are near the circular vessel. The proboscis is short and lacks a peduncle, and there are six slightly recurved lips. No gonads were observed. The entoderm of the proboscis, radial canals, and interradial tentacles is of a delicate pink. A single specimen of this medusa was obtained in a surface haul off the coast of Mexico.

S[4]; Station 3; August 28, 1899; N. Lat. 26° 18′, W. Long. 128° 54′.

Carmaris rosea, sp. nov.

Plate 4, fig. 18.

The bell is hemispherical, and about 6 mm. in diameter. The gelatinous substance is thick at the aboral pole, but diminishes toward the bell-margin, which is sharp-edged. There are twenty-four incisions, forming twenty-four distinct lappets upon the bell-margin. Two lappets are situated between each successive pair of tentacles. There are twelve tentacles. Six of these, which are long, flexible, and hollow, are situated at the bases of the six radial canals. These tentacles are thickly covered with rings of nematocyst cells, and are about as long as the bell-diameter. The six other

tentacles are solid, and are interradial in position. Their centrifugal sides are studded with about six to ten wart-like, nematocyst-bearing swellings. These tentacles are about as long as the bell-radius, and are carried curled stiffly upwards. There are twelve otocysts, one at the base of each tentacle. Each otocyst is hollow and contains a single spherical otolith. There are six broad, flat, radial canals, upon the mid-regions of which the gonads are developed. In addition to the radial canals there are eighteen blindly ending centripetal canals, three between each successive pair of radial canals. Six of these centripetal canals are longer than the others, and extend about half the distance from the bell-margin to the base of the stomach. The circular canal is wide and flat. The velum is well developed. The proboscis is long and pyriform, and the mouth projects beyond the level of the velar opening. The mouth is situated at the extremity of a long narrow neck, and there are six short, slightly recurved lips. The entoderm of the medusa is of a delicate rosy-pink, and all other parts are colorless. A single specimen was found in a surface haul made south of the Marquesas Islands.

S^d; Station 31; September 19, 1899; S. Lat. 12° 20′, W. Long. 144° 15′.

Aglaura prismatica Maas.

Aglaura prismatica Maas, 1897; Mem. Mus. Comp. Zoöl., Vol. XXIII., No. 1, p. 24, Pl. III., Figs. 4, 5.

We first obtained this medusa in N. Lat. 12° 7′, W. Long. 137° 18′; and thereafter it became one of the commonest objects in the tow. Large numbers were obtained among the Marquesas and Society Islands, and in 1897 we found it to be abundant among the Fiji Islands.[1] It was discovered in considerable numbers by the "Albatross" off the west coast of Mexico and Central America in 1891, and it seems safe to conclude that it is widely distributed over the tropical regions of the Pacific.

S^d; Station 12; September 4, 1899; N. Lat. 12° 07′, W. Long. 137° 18′.
S^d; " 13; " 5, " " 9° 57′, " 137° 47′.
S^a; " 15; " 8; " 4° 35′, " 136° 54′.
(300 f — $S)^a$; " 25; " 14; Marquesas Islands.
S^a; " 73; October 5; S. Lat. 17° 27′, W. Long. 149° 32′.
S^a; —— November 17; off Bora Bora Island, Society Islands.

[1] Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 165, Pl. 4, Fig. 13.

Ægina sp.

Two specimens of Ægina were obtained in an open net which was dragged from 250 fathoms to the surface. One of them was 28 mm. in diameter, and they both possessed four slender, slightly greenish-colored tentacles. They were too much damaged for description.

(250 f — S)[d]; Station 16; September 9; N. Lat. 2° 38′, W. Long. 137° 22′.

Solmaris sp.

Two specimens of Solmaris, one 25 mm. and the other 40 mm. in diameter, were brought up in an open net which had been dragged between 150 fathoms and the surface. They each had sixteen tentacles, and the gonads were of a milky-yellow color. Unfortunately the margins of their bells were too much damaged for specific identification.

(150 f — S)[d]; September 1, 1899; N. Lat. 17° 32′, W. Long. 135° 40′.

Solmissus marshalli, sp. nov.

Plate 5, figs. 23–25.

The disk consists of a thick doubly convex, central portion, and a thin outer annulus or collar region, and is 60 mm. in diameter. The gelatinous substance of the central region is very rigid, while that of the collar region is flexible. Fourteen equally spaced stiff tentacles arise from the periphery of the central disk. Each tentacle possesses a well developed conical insertion base. The entodermal cells of the tentacles are chordate, and are very thin and much crowded together.

A well developed peronial thickening extends radially outward from the base of each tentacle to the outer margin of the collar region. Owing to the specimen being in a somewhat imperfect condition, only one sense organ could be observed upon the outer edge of the collar region. This one contained a single highly refractive otolith of remarkably small size. The velum is well developed, and its powerful contractions serve to propel the animal through the water. The stomach is wide and flat, and gives rise to fourteen radiating pockets which are situated in the radii of the tentacles.

The mouth is a simple round opening at the centre of the sub-umbrella. The fourteen gonads are situated at the centripetal edges of the fourteen stomach pockets. The gonads and tentacles are slightly milky in color, while all other parts of the medusa are transparent. A single specimen was obtained off Kwajalong Atoll, Marshall Islands. It came up in an open net which had been towed between 150 fathoms and the surface.

(150 f — S)[d]; Station 220; January 16, 1900; N. Lat. 8° 38′, W. Long. 167° 37′.

Rhopalonema typicum Maas.

Homœonema typicum Maas, 1897; Mem. Mus. Comp. Zoöl., Vol. XXII., p. 22, Taf. III., Figs. 1–3.

Plate 5, figs. 21–22.

Maas describes this species from the west coast of Mexico. We first met with it on September 7, 1899, at N. lat. 6° 41′, W. long. 137°. We also found it at the Marquesas and Paumotus Islands, and at Tahiti. It was especially common in surface hauls made at night, and appeared to be most abundant about 3° north of the equator in W. long. 137°.

The bell is broad and hemispherical, and there is a small solid apical projection. The largest specimen obtained by us was about 15 mm. in diameter, but Maas records one of 20 mm. in breadth. The bell-walls are very thin but are remarkably stiff and rigid, swimming being accomplished by means of the strokes of the powerful velum which is exceedingly flexible. There are eight well developed tentacle bulbs situated at the bases of the eight radial canals. In addition to these there are about twenty-five or thirty smaller tentacles which are interradial in position. It seems probable that the shafts of all of the tentacles were broken off in all the specimens found by us, leaving only the basal bulbs. There are about sixteen exceedingly small otocysts upon the bell-margin, each one of which contains a single spherical otolith. The velum is large, and the contractions of its powerful muscles cause it to vibrate with remarkable rapidity. A well developed system of circular muscles is found in the ectoderm of the sub-umbrella. The proboscis is urn-shaped, the proximal part being narrower than the mid-region. There are four recurved lips. There are six gonads, one upon the middle region of each of the radial canals. Young

individuals are of a glassy transparency, while older ones are slightly translucent and milky in color, especially in the proboscis, gonads, and marginal tentacles.

S^a;	Station 14;	September	7, 1899;	N. Lat.	6° 41′,	W. Long.	137°.
S^n;	" 15;	"	8, "	"	4° 35′,	"	136° 54′.
S^n;	" 16;	"	9, "	"	2° 38′,	"	137° 22′.
S^n;	" 31;	"	19, "	S. Lat.	12° 20′,	"	144° 15′.
S^n;	" 32;	"	20, "	"	13° 37′,	"	145° 42′.
S^d;	——	"	23, "	Lagoon of Rangiroa Island, Paumotus Islands.			
S^n;	——	"	24, "	off Avatoru pass, Rangiroa.			
S^n;	——	October	5, "	off Pt. Venus, Tahiti.			

SCYPHOMEDUSÆ.

Charybdea grandis, sp. nov.

Plate 6, figs. 26–31.

Adult Medusa. The bell is high and cone-shaped, with a blunt apex. It is 230 mm. high, and 140 mm. in diameter. The gelatinous substance is quite thick and is of a remarkably tough consistency. There are four interradial, wing-like pedalia, the broad sides of which extend outward in a radial direction. These pedalia are each about 40 mm. long, and 25 mm. wide. A wide canal extends through the substance of each of them into the flexible portion of the tentacle, which arises from the distal end of the pedalium. The flexible part of the tentacle is about 140 mm. long, and its surface is ringed and covered with transverse rows of nematocyst cells (Fig. 28). Four sense organs, or rhopalia (Figs. 29, 30), alternate in position with the four tentacles. Each sense organ arises from a deep niche situated about 27 mm. above the level of the velarium. The sense organ is knob-shaped and is mounted upon a short stem, and contains from one to three ectodermal ocelli, and an entodermal otolith. In old medusæ there is usually a single, median ocellus in each sense organ, but in a young specimen 30 mm. in height there was a large median, and two small lateral ocelli. These ocelli are all directed so as to perceive objects within the bell-cavity. The velarium is well developed and is suspended by four mesenteries, or frenulæ, in the regions of the sense organs. Twenty-four short tree-like velar canals (Figs. 26, 31) extend centripetally

inwards into the substance of the velarium. The proboscis is short, and there are four slightly recurved lips. There are four interradial crescentic areas of numerous, short gastric cirri; the horns of each crescent pointing centripetally. Four wide radial pouches extend outward from the stomach. These pouches are separated one from another by four interradial partitions, but are placed in communication one with another by means of the lateral canals leading into the lumen of the pedalia. The gonads consist of eight leaf-like folds attached to the sides of the interradial septæ and hanging free in the radial pockets. The gelatinous substance of the bell is hyaline. The entoderm is translucent and milky white, and the gastric cirri and flexible parts of the tentacles are pink or yellow-pink. The sensory knobs of the rhopalia are dull ochre in color and the ocelli are deep brown — almost black. We first found a single specimen of this medusa in an open net which had been towed from a depth of 300 fathoms to the surface, south of Fakarava Island, Paumotus. The next day we discovered a large swarm of mature individuals off Anaa Island, floating very near the surface of the sea. This species is by far the largest Charybdea known.

(300 f — S)[d]; October 14, 1899; off Fakarava Atoll, Paumotus.
S[d]; —— " 15, " off Anaa Island, Paumotus Islands.

Nausithoë picta, sp. nov.

Plate 7, fig. 33.

The bell is quite flat and is 17 mm. in diameter. There are eight solid, stiff tentacles, each of which is about as long as the bell-radius. Eight marginal sense organs alternate with the tentacles. Each sense organ contains a centripetal ocellus and a centrifugal otolith. There are sixteen prominent marginal lappets which alternate in position with the tentacles and sense organs. The mouth is situated at the centre of the sub-umbrella, and is a cruciform slit surrounded by four simple, short lips. Four interradial groups of gastric cirri are arranged so as to alternate in position with the lips. Each of these groups contains about a dozen short cirri. There are eight large gonads which lie in the tentacular radii. In the female the ova are large and prominent. In the sub-umbrella there

is a well developed system of circular muscles which forms a ring, the outer circumference of which meets the bases of the tentacles, while the inner edge coincides in position with the middle points of the gonads. In addition to these circular muscles there are sixteen strands of radial muscles which extend outward on either side of the gonads to the middle of the lappets. There are also eight radial muscle strands in the ex-umbrella which extend outward toward the sense organs, and in addition to these there are eight well developed groups of radial muscles at the bases of the eight tentacles. The stomach consists of a wide lenticular space at the centre of the disk, and this gives rise to eight radial pouches extending outward in the radii of the eight sense organs. Each of these pouches bifurcates and sends a pair of branches into the lappets, making in all sixteen terminal pouches. The bell is translucent and milky in color. The ocelli and gonads are of a rich brown color, and the entodermal core of the gastric cirri are dark blue. Two specimens, one male and the other female, were found at night on the surface south of Rangiroa Island, Paumotus, on September 24, in S. lat. 15° 22′, W. long. 147° 57′.

Nausithoë punctata var. pacifica Agassiz and Mayer.

Nausithoë punctata var. **pacifica** Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 170.

Plate 7, fig. 32.

The disk is quite flat and is about 4 mm. in diameter. There are eight solid tentacles which are quite rigid. These tentacles are each about three-quarters as long as the bell-diameter. They arise from sockets on the sub-umbrella edge of the disk. There are sixteen sharply cleft marginal lappets, two between each successive pair of sense organs. The eight sense organs alternate in position with the eight tentacles, and are situated at the bottom of the niches between the lappets. Each sense organ contains a centrifugal otolith and a centripetal dark-brown ocellus. Eight gonads lie in the eight tentacular radii. In the female the ova are large and prominent. The mouth is a simple cruciform opening in the centre of the sub-umbrella, the arms of the cross passing through two of the tentacular diameters. There are four groups of gastric

cirri which alternate in position with the lips of the medusa. Each of these groups contain from four to seven cirri. The gelatinous substance is slightly bluish or milky in color, and the genital organs are dull cream or slightly ochre colored. In the majority of specimens there are no spots upon the ex-umbrella, but in some there is a brownish or yellowish spot upon the upper surface of each of the eight lappets. This form appears to differ from the Atlantic-Mediterranean species only in its duller coloration and the frequent absence of spots upon the ex-umbrella. Compare the Figure we here present with the drawing of the Atlantic species given in the Bull. Mus. Comp. Zoöl., Vol. XXXVII., Plate 26, Fig. 87.

We obtained this medusa in considerable numbers in Neiafu Harbor, Vavau Island, Tonga, on December 5 and 6, 1899, and we also found it among the Fiji Islands in December, 1897. Our Figure is taken from a specimen obtained near Suva, Fiji.

Atolla Alexandri Maas.

Atolla Alexandri Maas, 1897; Mem. Mus. Comp. Zoöl., Vol. XXIII., No. 1, p. 81, Taf. XI., Fig. 2, Taf. XIV., Figs. 4, 5.

A single specimen, in good condition, was brought up in a bottom trawl at 830 fathoms between Ua Huka and Marchand Islands, Marquesas, on September 14, 1899. It was 24 mm. in diameter, and there were forty-eight marginal lappets and twenty-four tentacles. A number of specimens of this deep-sea form were obtained by the "Albatross" in 1891 in trawls made off the Pacific coasts of Mexico and Central America.

Linerges aquila Haeckel.

Linerges aquila Haeckel, E., 1880; Syst. der Medusen, p. 496.

An immense swarm of ephyræ of this species, all about 3 mm. in diameter, were found in the lagoon of Hikueru Island, Paumotus, on October 27, 1899. Another swarm of somewhat older medusæ was met with in the lagoon of Funafuti, Ellice Islands, on December 24–25; and a single mature individual was captured in the lagoon of Rongelab Atoll, Marshall Islands, on January 17, 1900. We found large numbers of both ephyræ and mature medusæ of this species among the Fiji Islands in 1897.[1]

[1] Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 170, Pl. 10, Figs. 33, 34.

Zonephyra corona, sp. nov.

Plate 4, figs. 19, 20.

The bell is a little more than a hemisphere and is about 15 mm. in diameter. The gelatinous substance is quite thick at the aboral pole, but becomes thinner near the bell-margin. The surface of the ex-umbrella is thickly sprinkled with nematocyst cells. There are eight short hollow tentacles and eight marginal sense organs. Each sense organ contains an entodermal mass of red-colored granules. There are thirty-two broad lappets, two between each successive tentacle and sense organ. The sub-umbrella is provided with a well developed set of circular muscles. In addition to these there are sixteen spear-head-shaped radial muscle strands in the sub-umbrella; the broad ends of these muscle strands are centripetal. These strands extend to the notches between each successive tentacle and sense organ. Sixteen narrow radial muscle strands are also found in the ex-umbrella, and they alternate in position with the strands of the sub-umbrella. The proboscis is broad and flask-shaped, and there are four recurved, crenulated lips. The four gonads are interradial in position and are horseshoe shaped, the concavity being directed outward. Each gonad is thrown into complex corrugations, and in the female the eggs are easily seen on account of their deep purple color. Each gonad is provided with from eight to ten gastric cirri. The gastro-vascular cavity extends outwards in thirty-two pockets, one in each lappet. The gelatinous substance of the bell is of a greenish-amber tinge. The entoderm of the tentacles and the sensory entoderm of the marginal sense organs is of a claret color, as are also the eggs. The entire entoderm of the gastro-vascular cavity is of a delicate claret color, and the radial muscle strands of the sub-umbrella are of a glistening white. A single specimen of this medusa was found. It differs from the two species described by Haeckel, 1880, in that there are thirty-two lappets instead of sixteen as in Haeckel's forms.

S[4]; Station 14; September 7, 1899; N. Lat. 6° 41′, W. Long. 137°.

Pelagia tahitiana, sp. nov.

Plate 8, figs. 34, 35.

Immature individual. The disk is twice as broad as it is high, and is about 16 mm. in diameter. The ex-umbrella is quite regularly sprinkled over with large wart-like papillæ which bear nettling cells. The papillæ near the aboral apex of the disk are larger than the others, those near the bell-margin being very small. There are eight hollow tentacles, the distal three-quarters of which are covered profusely with nettling cells. These tentacles are each about three-quarters as long as the bell-diameter. Eight marginal sense organs alternate with the tentacles. Each sense organ contains a mass of dark-red pigment of entodermal formation. There are sixteen partially cleft lappets. The mouth is surrounded by four well developed crenulated palps which are about three-quarters as long as the bell-diameter. There are four inter-radial gonads, each one of which is horseshoe shaped, with its concave side turned outward (centripetally). Each gonad is furnished with from eight to twelve short gastric cirri and a well developed sub-genital pit. The stomach is a wide lenticular space at the centre of the disk. It gives rise to sixteen radial pockets which extend outward, eight to the tentacles and eight to the sense organs. These pockets are entirely separated each from each, and there is no ring canal. There is a well developed set of circular muscles in the sub-umbrella, and also a powerful radial set of sixteen muscle strands which alternate in position with the tentacles and sense organs, and extend down the septæ between the radial pockets. In addition to these there are sixteen radial muscle strands in the ex-umbrella. These extend to the bases of the tentacles and sense organs. The disk and palps are of a dull amber-yellow color and the tentacles are of a darker hue. The nematocyst cells over the ex-umbrella and the palps are orange-red, and the genital organs are of a dull ochre color. A single specimen of this medusa was found on the surface south of Rangiroa Island, Paumotus.

S^{a}; September 24, 1899; off Rangiroa, Paumotus Islands.

Aurelia vitiana Agassiz and Mayer.

Aurelia vitiana Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 171, Plate 10, Fig. 35.

This species was very abundant upon the surface during the afternoon hours in Neiafu Harbor, Vavau Island, Tonga, on December 5 and 6, 1899. None were to be seen in the morning. We found it also in Suva Harbor, Fiji, in December, 1897; but here it appeared during the early morning hours, and then only on perfectly calm days. It is interesting that although it was very calm while we were in Neiafu Harbor, yet the medusæ did not come to the surface in the morning, but swarmed there during the afternoon.

SIPHONOPHORÆ.

Porpita pacifica Lesson.

Porpita pacifica Lesson, R. P., 1830; Voy. de la "Coquille," Zoöl., Tom. 2, Zoöphytes, Pl. 7, Figs. 3, 3′.

This species is widely distributed over the tropical belt of the Pacific. The general color of the pneumatocyst and polypites is not so gray but more yellowish than in Lesson's figure.

S^a;	Station 7;	September 1, 1899;	N. Lat. 18° 19′,	W. Long. 134° 57′.
S^d;	" 13;	" 5, "	" 9° 57′,	" 137° 47′.
S^f;	" 31;	" 19, "	S. Lat. 12° 20′,	" 144° 15′.
S^g;	——	November 17, "	off Bora Bora Island, Society Islands.	
S^d;	——	December 25, "	Lagoon of Funafuti Atoll, Ellice Islands.	

Velella pacifica Eschscholtz.

Velella pacifica Eschscholtz, F., 1829; Syst. der Acalephen.

S^f;	Station 14;	September 7, 1899;	N. Lat. 6° 41′, W. Long. 137°.
S^d;	——	November 16, "	Tahaa Island, Society Islands.

DIPHYOPSIS APPENDICULATA.

ERSÆA APPENDICULATA.

Diphyopsis appendiculata Agassiz and Mayer.

Diphyes appendiculata Eschscholtz, F., 1829; Syst. der Acalephen, p. 138, Taf. XII., Fig. 7.
Diphyes appendiculata Huxley, T. H., 1859; Oceanic Hydrozoa, p. 34, Pl. I., Figs. 2–2e.

Plate 9, figs. 38, 39.

This species was first obtained by the "Albatross" in N. lat. 17° 32′, W. long. 135 40′, and it continued to be abundant throughout the tropical regions of the Pacific. In the Pacific species the entoderm of the polypites and nematocyst batteries is milky, or slightly yellow or pink in color, while in the Atlantic form the polypites are of a more or less intense green and the nematocyst batteries of the tentacles are yellow or orange (see Bull. Mus. Comp. Zoöl., Vol. XXXVII., No. 2, Pl. 34, Fig. 114). A still more important difference between the two species lies in the fact that in the Pacific form the monogastric sexual generation belongs to the genus Ersæa, and lacks a manubrium within its swimming-bell; while in the Atlantic form it belongs to the genus Eudoxia, for it possesses a manubrium within its bell. The Pacific form, therefore, is a Diphyopsis, while the Atlantic form belongs to the genus Diphyes.

The animal is 18–20 mm. in length, and the anterior swimming-bell is somewhat larger than the posterior. The anterior bell is angular and pyramidal and its cavity is voluminous. There are two ascending, curved radial canals and a simple circular vessel. The phyllocyst is long and narrow and contains an "oil globule" near its distal extremity. There is a moderately deep conical hydrœcium upon the ventral face of the anterior nectophore, and the siphosome arises from its inner apex. The first appendage of the siphosome is the large posterior swimming-bell (*p s*, Fig. 39). This is somewhat smaller than the anterior bell, and a deep groove covered by a projecting tooth runs down the side upon which the siphosome is situated. Indeed the siphosome lies within this groove and is protected by the covering tooth. The second appendage of the siphosome is the small auxiliary swimming-bell (*a s*, Fig. 39). Immediately below this comes a cluster of immature feeding polypites, the older ones being successively

lower down the siphosome. The tentacles bud out from the sides of the polypites, and then come the bracts which protect them. The units upon the siphosome are separated by free internodes. When set free as Ersæa appendiculata, each unit is provided with a covering scale, polypite, tentacle, and immature swimming-bell.

S^a;	Station	7;	September	1,	1899;	N. Lat.	18° 19′,	W. Long.	134° 57′.	
S^c;	"	12;	"	4,	"	"	12° 07′,	"	137° 18′.	
(150 f — S)^d;	"	15;	"	8,	"	"	4° 35′,	"	136° 54′.	
(250 f — S)^d;	"	16;	"	9,	"	"	2° 38′,	"	137° 22′.	
(300 f — S)^a;	"	25;	"	14,	"	Marquesas Islands.				
S^a;	"	31;	"	19,	"	S. Lat.	12° 20′,	W. Long.	144° 15′.	
S^d;	"	32;	"	20,	"	"	13° 37′,	"	145° 42′.	
S^d;	——		October	23,	"	Lagoon of Makemo Island, Paumotus Islands.				
S^f;	——		"	28,	"	off Marokau, Paumotus Islands.				
S^d;	——		December	24,	"	Lagoon of Funafuti, Ellice Islands.				

Ersæa appendiculata.

Plate 9, fig. 40.

The mature animal is 5 mm. in length. The anterior covering scale is irregularly pyramidal, one face being plane, with angular edges. The ventral side is concave and fits over the anterior part of the swimming-bell. The phyllocyst is long and is composed of highly vacuolated cells, and there is generally an "oil globule" near its distal extremity. The swimming-bell is quadratic in cross-section, having four longitudinal, sharp edges. The cavity of the bell is quite wide at the base, but tapers to a narrow inner apex. There is no manubrium, but there are four straight, narrow, radial canals and a simple circular vessel. The velum is well developed, and its contractions serve to drive the animal forward with considerable speed. The single polypite is fusiform, and its entodermal gastric cells are arranged in wart-like protuberances upon the inner wall of the stomach. There is a single tentacle which gives rise to side branches, each one of which terminates in a well developed nematocyst battery. Several gonophores in various stages of development arise from the side of the polypite immediately proximal to the tentacle. Each gonophore contains four simple radial canals and a circular vessel. The entoderm of the polypite is usually faint yellow, but occasionally it is of a delicate pink or milky color. The radial canals of the swimming-bell are usually colorless, but sometimes they are tinged with yellow spots. This form is common every-

where in the tropical Pacific wherever the Diphyes generation is found. This species may be Eudoxia Lessoni of Eschscholtz, figured by him in Syst. d. Acal., p. 126, Taf. XII., Fig. 2, and by Huxley in 1859 under the same name in Oceanic Hydrozoa, p. 57, Pl. III., Fig. 6.

DIPHYOPSIS ANGUSTATA.

ERSÆA ANGUSTATA.

Diphyopsis angustata Haeckel.

Diphyes angustata Eschscholtz, F., 1829; Syst. der Acal., p. 136, Taf. 12, Fig. 6.
Diphyopsis angustata Haeckel, 1888; Challenger Report, Zoöl., Vol. XXVIII., p. 152.

Plates 8, 10, figs. 37, 42.

This species was first obtained by the "Albatross" in N. lat. 6° 41′, W. long. 137°, and from this time on throughout the cruise in the tropical regions of the Pacific it continued to be the commonest of all Siphonophoræ. Several perfect specimens were obtained in which the posterior nectophore remained attached to the siphosome. This is very readily broken off at the time of capture, and it was not observed in any of the specimens obtained by us in 1897 among the Fiji Islands (see Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 179, Pl. 17, Fig. 54). The posterior swimming-bell is quite similar in relative size and general appearance to that of D. compressa figured by Haeckel, 1888; in Siphonophoræ of the "Challenger" expedition, Pl. XXXIII., Figs. 1–4.

We give two figures, one showing a complete unit of the siphosome a short time before it is detached from the stem, and the other a drawing of the terminal nematocyst battery of the tentacles. The monogastric sexual generation, Ersæa angustata, nov. sp., was met with quite frequently.

S^{d}, S^{n};	Station	14;	September	7,	1899;	S. Lat. 6° 41′, W. Long. 137°.
(300 f — S)^{n};	Station	25;	September	14,	1899;	Marquesas Islands.
(300 f — S)^{d}, S^{d};	"	30;	"	18,	"	S. Lat. 10° 29′, W. Long. 141° 52′.
(300 f — S)^{d}, S^{d};	"	32;	"	20,	"	" 13° 37′, " 145° 42′.
S^{n};	——		October	5,	"	off Point Venus, Tahiti.
S^{d};	——		"	14,	"	off Fakarava Atoll.
S^{d};	——		"	23,	"	Lagoon of Makemo Island, Paumotus Islands.
S^{d};	Station	173;	November	4,	"	S. Lat. 18° 55′, W. Long. 146° 32′.
S^{d};	"	180	"	15,	"	" 17° 30′, " 149° 41′.
S^{d};	——		December	25,	"	Lagoon of Funafuti, Ellice Islands.
S^{n};	——		January	20,	1900;	Lagoon of Likieb, Marshall Islands.

Ersæa angustata, sp. nov.

Plate 10, fig. 41.

The animal is about 6 mm. in length. The anterior covering-scale is irregularly pyramidal and is provided with a deep fissure upon its ventral face, which embraces the upper portion of the large posterior swimming-bell. The upper apex of the anterior covering-scale is usually pointed, and the two dorsal edges are quite sharp and angular. The phyllocyst is long and sometimes contains a highly refractive "oil globule," situated near its distal extremity. The single feeding polypite is quite long and is capable of being extended beyond the lower edge of the covering-scale. A group of tentacles arises from its side, and immediately above this there are one or two gonophores in various stages of development. The entoderm of the polypite and phyllocyst is rose-colored, while the terminal nematocyst batteries of the tentacles are orange as in the Diphyopsis generation. The posterior swimming-bell is rectangular in cross-section with four sharp-edged longitudinal ridges, which are often serrate. A deep trough-like longitudinal groove extends down the ventral side of the swimming-bell. The bell-cavity is irregularly conical, and the velum is very powerful. There are four straight, narrow, radial canals and a simple, slender, circular canal; and these are placed in communication with the gastrovascular space of the polypite by means of a short, straight duct. There is no manubrium within the swimming-bell.

This Siphonophore may readily be distinguished from the Atlantic form by its pink coloration, the Atlantic species being green.

Abyla quincunx Chun.

Abyla quincunx Chun, C., 1897; Verhandl. d. Deutsch. Zool. Gesell., p. 71, Fig. 13. (Atlantic form.)

Plate 11, figs. 46, 47.

Aglaisma quincunx Mayer.

Aglaisma quincunx Mayer, 1900; Bull. Mus. Comp. Zoöl., Vol. XXXVII, p. 78. (Atlantic form.)

Plate 10, fig. 45.

A large number of specimens of this Siphonophore were obtained throughout the Tropical regions of the Pacific. A comparison of the Figures here given with those of the Atlantic form by Chun, 1897, and Mayer, 1900, will serve to show the close relationship which exists between the Pacific and the Atlantic representatives of this Siphonophore. It will be noticed that in Figure 45 a saw-toothed projection extends down the open groove of the inferior nectophore, and that this is absent in the Figures of the Atlantic form given by Chun and Mayer. This peculiarity is, however, not seen in all individuals, and seems to occur quite as commonly in the Atlantic as in the Pacific specimens, and it cannot, therefore, be used as a basis of distinction between them. The Pacific and Atlantic specimens are, moreover, of the same size, being about 7–9 mm. in length for the Diphyes, and 4–5 mm. for the Aglaisma generation. The only fairly constant difference appears to be that in the Atlantic specimens the terminal nematocyst batteries of the tentacles are usually orange or yellow in color, whereas in the Pacific forms they are generally colorless. This distinction is not invariable, however, for some Pacific specimens are found in which they are slightly yellow, while other specimens from the Atlantic have them colorless.[1] We therefore conclude that there can be, at most, but a varietal difference between the Atlantic and Pacific forms of this Siphonophore, and venture to assert that they belong to the same species.

(300 f — S)^{a};	Station	25;	September	14, 1899;	Marquesas Islands.
(300 f — S)^{d};	"	30;	"	18, "	S. Lat. 10° 29′, W. Long. 141° 52′.
(300 f — S)^{d}, S^{f};	——		October	28, "	off Marokau Island, Paumotus.
S^{d};	Station	173;	November	4, "	S. Lat. 18° 55′, W. Long. 146° 32′.
S^{a};	——		December	"	Suva Harbor, Fiji Islands.
S^{d};	——		"	25, "	Lagoon of Funafuti, Ellice Islands.

[1] We had also found this species in Fiji in 1897–98. See Bull. Mus. Comp. Zoöl., 1899, Vol. XXXII., No. 9, p. 180.

Abyla Leuckartii Huxley.

Abyla Leuckartii Huxley, T. H., 1859; Oceanic Hydrozoa, p. 49, Pl. III., Figs. 2–2ᵇ.

Two specimens of this Siphonophore were obtained by the "Albatross," one in the Marquesas, and the other about 100 miles north of the Paumotus Islands. Huxley found it off the east coast of Australia. The smaller of our specimens is well represented by Huxley's Figure 2; in the larger, however, the anterior nectophore is 22 mm. in length and has the shape of a narrow, elongate, five-sided pyramid; the apex of which is sharp and pointed. It is much flattened laterally in the plane passing through the axes of the phyllocyst, hydrœcium, and bell-cavity. The cavity of the anterior swimming-bell is long and tapers to a point very near the apex of the bell. There are four radial canals and a simple circular vessel, and these are put into connection with the gastro-vascular cavity of the hydrosoma by means of a short, straight duct, which reaches the side of the bell-cavity at about its middle point. The velum is well developed and is provided with powerful muscles by the rapid contraction of which the animal is enabled to dart through the water. A deep, funnel-shaped hydrœcium is situated midway between the bell-cavity and the phyllocyst. The hydrosoma arises from the inner apex of this cavity. In both Huxley's and our specimens there were but two well developed polypites, but there were several other smaller ones, probably in course of development. The largest polypite is terminal and a cluster of small or undeveloped tentacles arises from the side of its proximal end. Among these tentacles there is one which is much longer than the rest, and this one terminates in a coiled, helical, nematocyst battery. The nematocyst batteries of the short tentacles, however, are straight and finger shaped. Close to the proximal end of the hydrosoma there is a cluster of small immature polypites and among them a single small, auxiliary swimming-bell. No large inferior swimming-bell existed either in Huxley's or in our specimens, and it is probable that it had been lost through accident. The phyllocyst is large and cucumber shaped, and is connected with the hydrosoma by means of a short, straight duct. It lies imbedded in the gelatinous substance, and extends downward parallel with the longitudinal axis of the animal. It is composed of large,

highly vacuolated, reticulated cells; and contains several small "oil globules." The gelatinous substance of the animal is of a translucent milky color, the entoderm of the polypites being somewhat more opaque. In one of our specimens the phyllocyst was milky, while in the other it was of a decided green color. This form is evidently quite closely related to Abyla carina (Haeckel 1888; Siphonophoræ, "Challenger" Report Zoöl., Vol. XXXVIII., Pl. 35) of the Tropical Atlantic.

S^d; Station 27; September 15, 1899; off Marchand Island, Marquesas.
S^d; " 32; " 20, " S. Lat. 13° 37′, W. Long. 145° 42′.

Abyla Huxleyi Haeckel.

Abyla pentagona Huxley, T. H., 1859; Oceanic Hydrozoa, p. 40, Pl. II., Figs. 2–2^e.
Calpe Huxleyi Haeckel, E., 1888; Siphonophoræ, "Challenger" Report, Zoöl., Vol. XXVIII., p. 164.

Plate 11, fig. 48.

A number of specimens of the tropical Pacific form of Abyla were found by us at various places during the cruise through the warm regions of the ocean. The Pacific species is certainly very close to, if not identical with, the Atlantic form (see Calpe Gegenbauri, Haeckel, 1888; p. 164, Pls. XXXIX., XL.). The remarkable range of individual variability in different specimens, and the great difference which arises with successive stages of growth, renders it extremely difficult to decide whether the Atlantic and Pacific forms be identical or not. The only difference which seems to be fairly constant is that in the Pacific form the entoderm of the feeding polypites is usually milky in color, whereas in the Atlantic form it is generally of a more or less decided green. The Pacific species attains a length of about 25 mm. We give a figure drawn from an individual obtained near Rongelab Atoll, Marshall Islands. Other specimens were obtained in the Marquesas, Paumotus, Society, and Ellice Islands.

S^d; —— September 15, 1899; Tai-o-hae, Marquesas Islands.
(300 f — S)^d; Station 32; " 20, " S. Lat. 13° 37′, W. Long. 145° 42′.
S^a; —— November 17, " off Bora Bora Island, Society Islands.
S^a; —— December 24, " Lagoon of Funafuti, Ellice Islands.
(150 f — S)^d; —— January 17, " off Rongelab Atoll, Marshall Islands.

Anthemodes Moseri,[1] sp. nov.

Plate 12, figs. 49–57.

The entire animal varies in length from about 100 mm. to 450 mm., according to its state of contraction. All of the units arise from one and the same side of the stem, although the twisting of the animal often gives one the impression that this is not the case.

The pneumatophore is small and pyriform and is situated at the anterior extremity of the nectosome. Its opening is small and circular, and is situated at the pointed anterior end of the organ. Gas may be extruded through this opening, thus enabling the animal to alter its specific gravity, become less buoyant, and sink.

The nectosome is a straight, rigid tube, which comprises about one-fifth of the entire length of the animal. It is provided with from twenty to thirty diametrically opposed, dove-tailed swimming-bells, the sudden and simultaneous contraction of which enables the animal to dart through the water with remarkable rapidity. The gelatinous substance of these swimming-bells is tough and rigid, and their cavities are capacious. Each bell (Fig. 51) is provided with four radial canals, a circular vessel, and a well developed velum.

The siphosome is highly flexible and contractile and is covered throughout its length with numerous tough, gelatinous, spear-head shaped bracts (Figs. 55–57). The various groups of units upon the siphosome are separated by free internodes.

There are about two dozen (only six are shown in Fig. 49) feeding-polypites (Fig. 53). These are separated from one another by long intervals. Each polypite is attached to the stem by means of a short, cylindrical pedicle. The body of the polypite is long, slender, and flexible, and the mouth is capable of being expanded into a trumpet shape. Several small rudimentary, or immature, and a single long, functional tentacle arise from the side of the polypite near the distal end of the pedicle. The tentacles

[1] Named after Commander Jefferson F. Moser, U. S. N., in command of the U. S. F. C. S. "Albatross."

give rise to several side branches, and each of these, as well as the distal end of the tentacle itself, terminates in a coiled nematocyst battery, protected by a gelatinous funnel-shaped hood, and ending in a simple terminal filament (Fig. 54).

The gonostyles (Fig. 52) are much more numerous than the feeding polypites. They are spindle shaped and are attached to the siphosome by means of a short, cylindrical pedicle. It is probable that there is an opening at the distal extremity of each of these organs, and that they are, therefore, equivalent to the Cystons of Haeckel. A single long, slender, unbranched tentacle arises from the upper side of each gonostyle near the distal end of the pedicle. Clustered near the base of this tentacle there are three or four male and from six to ten female gonads. The male gonads are long and finger shaped and contain each a single unbranched axial canal. The female gonads are small and spherical and each one contains a single ovum, which is surrounded by a winding system of slender canals.

The entoderm of the siphosome and feeding polypites is slightly milky in color, while the gelatinous substance of the swimming-bells and bracts is of a glassy transparency. The pore of the float is surrounded by port-wine-colored polygonal cells, and the invaginated portion of the float is of a delicate amber hue. The entoderm of the nectosome and siphosome is marked with small, scattered port-wine-colored blotches. There are two port-wine-colored spots at the distal ends of each of the two lateral radial canals in every swimming-bell; and the entoderm of the gonostyles and feeding polypites is marked with the same color. The nematocyst cells in the batteries of the lateral tentacles are of a deep port-wine color, as are also parts of the entoderm of the male gonophores.

Large numbers of this beautiful siphonophore were found swimming during the morning hours, upon the surface, in the lagoon of Funafuti Atoll, Ellice Islands, on December 24–26, 1899.

This Pacific species differs in many respects from the Atlantic form of the genus described by Haeckel, 1888; "Challenger" Report, Zoöl., Vol. 28, p. 229, Pls. XIV., XV.

Nectophysa Wyvillei? Haeckel.

Nectophysa Wyvillei Haeckel, 1888; "Challenger" Report, Zoöl., Vol. XXVIII., p. 327, Plate 23.

Plate 8, fig. 36.

A single specimen of a Siphonophore that we are unable to distinguish from N. Wyvillei was found by us on August 28. The specimen came up attached to the end of a wire rope, which had been lowered to a depth of 500 fathoms. Haeckel's specimens were found at Lanzerote, Canary Islands. The pneumatophore of our specimen is egg-shaped and the pore is situated at its upper apex. The invaginated air-sac hangs free in the general cavity of the pneumatophore, and gives rise at its lower end to a number of finger-shaped villi, which branch sparsely and irregularly. The feeding polypites and tentacles all arise from one side of the stem. The polypites are elongate and flask-shaped and are capable of much contraction or expansion. The mouth is often seen expanded outwards in a trumpet shape. A single tentacle arises from the upper side of each feeding polypite. Simple unbranched tentilla arise at regular intervals from the side of each tentacle. The body of the pneumatophore is clear amber-yellow color, and an iris-like ring, composed of radiating lines of deep brown pigment, surrounds the pore of the air-sac. The entoderm of the air-sac near the region of the pore is pink in color. The stem and feeding polypites are pink. The main shafts of the tentacles are transparent and the side branches are of a fleshy-pink color. The animal was about 300 mm. in length when expanded, and the pneumatophore was 6 mm. long and 4 mm. in diameter. No gonads were observed.

Station 3; August 28, 1899; N. Lat. 26° 18′, W. Long. 128° 54′.

Physalia utriculus Eschscholtz.

Physalia utriculus Eschscholtz, F., 1829; Syst. der Acal., p. 163, Taf. XIV., Figs. 2, 3.

Plate 10, figs. 43, 44.

A large number of specimens of this Siphonophore were found by us throughout the Tropical regions of the Pacific. The adult has been well figured by Lesson (1830; Voy. de la "Coquille," Zoophytes, Pl. V., Fig. 1).[1]

[1] See also Huxley, T. H., 1859; Oceanic Hydrozoa, p. 101, Pl. X., Figs. 1–15[c], Pl. XII., Fig. 12.

A number of young individuals between 2 mm. and 4 mm. in length were found by the "Albatross" among the Paumotus and Society Islands. Those 2 mm. in length (Fig. 43) possess but one primary axial polypite, from the side of which there arises a single tentacle. This tentacle bears a number of wart-like nematocyst-bearing swellings upon one side. The float at this stage is simple and terminal, and the air-sac is oval and communicates with the outer world by means of an apically situated pore. The gastric portion of the axial polypite contains a number of disk-shaped hepatic villi. Two very small evaginated protuberances are seen projecting outward from the ventral floor of the float. These are the beginnings of the secondary polypites and tentacles, which in the adult are much larger and more numerous than the primary. In specimens about 4 mm. in length (Fig. 44) the secondary tentacle has become larger than the primary, and there are several feeding polypites of the secondary set budding outward around its conical base.

Unlike the adult, these young individuals possess the ability to sink beneath the surface; a feat which they accomplish by extruding a bubble of gas through the pore of the float. In a few minutes the gas regenerates, and then the animals rise to the surface. Figure 44 shows the creature in the act of forcing a gas bubble out of the pneumatophore, and it will be seen that the muscular inner wall of the air-sac exhibits an annular contraction.

S′; Station 13; September 5, 1899; N. Lat. 9° 57′, W. Long. 137° 47′.
S′; " 14; " 7, " " 6° 41′, " 137°.
S′; " 16; " 9, " " 2° 38′, " 137° 22′
S′; " 173; November 4, " S. Lat. 18° 55′, " 146° 32′.
S′; —— January 22, 1900; Lagoon of Wotje, Marshall Islands.
S; Fiji Islands; 1897–98.

CTENOPHORÆ.

Pleurobrachia ochracea, sp. nov.

Plate 13, fig. 58.

The animal is egg-shaped and about 12 mm. in length. The body is somewhat compressed in the diameter perpendicular to the tentacular axis. The aboral pole is quite blunt. The outer surface is smooth and there are no papillæ. The apical sense organ is quite large and contains a mass of spherical otoliths. There are eight meridional canals which extend

from the region of the apical sense organ to about two-thirds the distance down the sides of the animal, and end blindly. Eight rows of ciliated plates follow the courses of the eight meridional canals and extend about two-thirds of their length. Each of these rows contains about fifteen combs of cilia. The lateral tentacles arise from the bottom of two deep, narrow clefts, one in each side in the plane of the wide lateral diameter of the animal. These clefts open quite high up on the sides not far from the aboral pole, but their deep-lying portions extend downward to about one-third of the distance from the mouth to the apex. The two lateral tentacles are simple and quite thick, and no lateral tentacula were observed, although a large number of specimens were examined. In this respect this species differs from all other Pleurobrachiæ. The mouth is a narrow slit. The funnel canal and the radiating canals to the meridional vessels are straight and slender. The entoderm of the stomach is of a decided yellow color and the tentacles are slightly milky, all other parts of the animal being of a glassy transparency.

This Ctenophore was first obtained in N. lat. 31° 10′, W. long. 125°. It became rarer as we went southward, and disappeared before we reached the Tropics.

S^{d}; Station 1; August 26, 1899; N. Lat. 31° 10′, W. Long. 125°.
S^{d}; " 6; " 31, " " 20° 26′, " 133° 28′.

Lampetia fusiformis, sp. nov.

Plate 13, figs. 59, 60.

The animal is narrow and pear-shaped, and about 40 mm. in length. The oral pole is long and narrow, and the aboral quite blunt. The body is compressed laterally, the tentacular diameter being the longer. The apical sense organ is half egg-shaped and contains a large mass of otoliths. It is surrounded by raised ridges. The eight meridional canals arise from the vicinity of the apical sense organs and extend about two-thirds the distance down the sides of the body, where they end blindly. Each canal is covered throughout its length with numerous (about forty) combs of ciliated plates. The lateral tentacles arise from the bottom of long, narrow, tortuous clefts, which open upon the sides of the body about one-

third of the distance down from the apical sense organ. These clefts extend downward along the sides of the stomach for about three-quarters of the distance between the apex and the mouth. The tentacles are capable of considerable expansion and contraction, and are furnished with simple lateral branches. The mouth is a narrow slit at the bottom of a shallow trough in the oral pole of the animal. The stomach is flat and narrow and gives rise to two blindly ending lateral canals in the tentacular diameter. These canals extend downward along the sides of the stomach to points very near the region of the mouth. The funnel canal and the radiating canals, which connect the middle points of the meridional vessels with the stomach, are quite broad and straight. The tentacles are milky in color, and the entoderm of the stomach is of a faint steely blue. All other parts of the animal are of a glassy transparency.

This Ctenophore was first obtained in N. lat. 28° 11′, W. long. 111° 16′. It became more and more abundant as we approached the Tropics, and we met with swarms of them among the Paumotus Islands.

S^d;	Station	2;	August	27,	1899;	N. Lat.	28° 23′,	W. Long.	126° 57′.	
S^a;	"	7;	September	1,	"	"	18° 19′,	"	131° 57′.	
S^d;	"	14;	"	7,	"	"	6° 41′,	"	137°.	
S^a;	"	14;	"	7,	"	"	5° 40′,	"	136° 47′.	
S^a;	"	15;	"	8,	"	"	4° 35′,	"	136° 54′.	
S^a;	"	16;	"	9,	"	"	2° 38′,	"	137° 22′.	
S^a;	——		"	21,	"	Lagoon of Rangiroa Island, Paumotus Islands.				
S^d;	——		"	23,	"	"	"	"	"	"
S^a;	——		"	24,	"	off south shore of Rangiroa Island.				

Cestus sp.

Several fragments of a Cestus, the largest being about 100 mm. in length and 23 mm. in width, were found by the "Albatross."

S^a; Station 14; September 7, 1899; N. Lat. 6° 41′, W. Long. 137°.
S^d; " 15; " 8, " " 4° 35′, " 136° 54′.

Beroë australis Agassiz and Mayer.

Beroë australis Agassiz and Mayer, 1899; Bull. Mus. Comp. Zoöl., Vol. XXXII., p. 177, Pl. 16, Figs. 49, 50.

A single specimen of this Ctenophore was captured by the "Albatross."

S^d; December 23, 1899; off Funafuti, Ellice Islands.

EXPLANATION OF THE PLATES.

PLATE 1.

Fig. 1. *Tiara occanica*, sp. nov.
" 2. *Turris pelagica*, sp. nov.
" 3. *Psythia prolifera*, gen. et sp. nov.
" 4. *Epenthesis rangiroæ*, sp. nov.

PLATE 2.

Fig. 5.	*Phortis elliceana*, sp. nov.	
" 6.	" "	Gastric portion of the proboscis.
" 7.	" "	Portion of the bell-margin.
" 8.	*Bougainvillia fulva* Agassiz and Mayer.	Mature medusa.
" 9.	*Lymnorea ocellata*, sp. nov.	Side view of mature medusa.
" 10.	" "	Side view of a tentacle-bulb, showing the ectodermal ocellus.
" 11.	" "	Terminal portion of one of the oral tentacles.
" 12.	" "	Nematocyst capsules on the terminal portion of one of the oral tentacles.

PLATE 3.

Fig. 13.	*Dipleurosoma pacifica*, sp. nov.	Oral view of mature medusa.
" 14.	" "	Portion of the bell-margin.
" 15.	*Rhegmatodes lacteus*, sp. nov.	
" 16.	" "	Portion of the bell-margin.

PLATE 4.

Fig. 17.	*Geryones mexicana*, sp. nov.	Immature medusa.
" 18.	*Carmaris rosea*, sp. nov.	
" 19.	*Zonephyra corona*, sp. nov.	Side view of mature medusa.
" 20.	" "	Oral view of one of the marginal sense organs.

PLATE 5.

Fig. 21.	*Rhopalonema typicum* = *Homœonema typicum* Maas.	
" 22.	*Rhopalonema typicum.*	Portion of bell-margin showing the very minute otocysts.
" 23.	*Solmissus marshalli*, sp. nov.	Side view, natural size.
" 24.	" "	Oral view of medusa, natural size.
" 25.	" "	View of marginal sense organ.

PLATE 6.

Fig. 26.	*Charybdea grandis*, sp. nov.	Side view of a young medusa.
" 27.	" "	Side view of a tentacle from a mature medusa, natural size.
" 28.	" "	Enlarged view of a portion of the flexible part of the tentacle, showing the linear arrangement of the nematocysts.
" 29.	" "	Enlarged side view of a sense organ of a mature medusa.
" 30.	" "	Surface view of a sense organ of a young medusa.
" 31.	" "	Enlarged view of one of the velar canals.

PLATE 7.

Fig. 32.	*Nausithoë punctata* var. *pacifica* Agassiz and Mayer.	
" 33.	*Nausithoë picta*, sp. nov.	Oral view of ♀ medusa.

PLATE 8.

Fig. 34.	*Pelagia tahitiana*, sp. nov.	
" 35.	" "	Oral view of a portion of the disk.
" 36.	*Nectophysa Wyvillei?* Haeckel.	
" 37.	*Diphyopsis angustata* Haeckel.	Terminal nematocyst-battery of a tentacle.

PLATE 9.

Fig. 38.	*Diphyopsis appendiculata.*	Side view of the polygastric generation.
" 39.	" "	Side view of the siphosome, showing the order of development of the the polypites, tentacles, and bracts. (*ps*) Inferior swimming-bell; (*as*) auxiliary swimming-bell.
" 40.	*Ersœa appendiculata.*	The monogastric, sexual generation of Diphyes appendiculata.

PLATE 10.

Fig. 41.	*Ersæa angustata*, sp. nov.	The monogastric sexual generation of Diphyopsis angustata.
" 42.	*Diphyopsis angustata* Haeckel.	Enlarged view of one of the units upon the siphosome. (*b*) Immature swimming-bell; (*c*) covering-scale; (*p*) polypite; (*ss*) siphosome; (*t*) tentacle.
" 43.	*Physalia utriculus* Eschscholtz.	Young individual 2 mm. in length; with primary polypite and tentacle.
" 44.	" " "	Young individual 4 mm. in length; with secondary tentacle and polypite.
" 45.	*Aglaisma quincunx* Mayer.	The monogastric sexual generation of Abyla quincunx.

PLATE 11.

Fig. 46.	*Abyla quincunx* Chun.	Specimen obtained at Suva, Fiji.
" 47.	" " "	Terminal nematocyst-battery of a tentacle.
" 48.	*Abyla Huxleyi* = *Calpe Huxleyi* Haeckel.	

PLATE 12.

Fig. 49.	*Anthemodes Moseri*, sp. nov.	The entire animal.
" 50.	" "	Side view of the float.
" 51.	" "	Side view of a swimming-bell.
" 52.	" "	A gonostyle. ♂ male, ♀ female gonophores.
" 53.	" "	A feeding polypite.
" 54.	" "	Side view of one of the terminal nematocyst-batteries of the tentacles.
" 55.	" "	Side view of an immature bract.
" 56.	" "	View looking down on a mature bract, showing the upper surface.
" 57.	" "	Lower surface of a mature bract.

PLATE 13.

Fig. 58.	*Pleurobrachia ochracea*, sp. nov.	
" 59.	*Lampetia fusiformis*, sp. nov.	
" 60.	" "	Side view of apical sense organ.

PLATE 14.

Track of the "Albatross."

ALPHABETICAL LIST OF SPECIES.

HYDROMEDUSÆ.

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Aglaura prismatica Maas	150
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Carmaris rosea, sp. nov.	149
Dipleurosoma pacifica, sp. nov.	148
Epenthesis rangiroæ, sp. nov.	145
Geryones mexicana, sp. nov.	149
Liriope hyalina Agassiz and Mayer	148
Lymnorea ocellata, sp. nov.	144
Mesonema macrodactylum Brandt	147
Phortis elliceana, sp. nov.	146
Polycanna purpurostoma Agassiz and Mayer	147
Psythia prolifera, gen. et sp. nov.	143
Rhegmatodes lacteus, sp. nov.	147
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Nausithoë picta, sp. nov.	154
Nausithoë punctata var. pacifica Agassiz and Mayer	155
Pelagia tahitiana, sp. nov.	158
Zonephyra corona, sp. nov.	157

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Abyla Huxleyi = Calpe Huxleyi Haeckel	166
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Diphyopsis angustata Haeckel; Ersæa angustata, sp. nov.	162
Diphyopsis appendiculata Eschscholtz; Ersæa appendiculata, sp. nov.	160
Nectophysa Wyvillei ? Haeckel	169
Porpita pacifica Lesson	159
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CTENOPHORÆ.

Beroë australis Agassiz and Mayer	172
Cestus sp.	172
Lampetia fusiformis, sp. nov.	171
Pleurobrachia ochracea, sp. nov.	170

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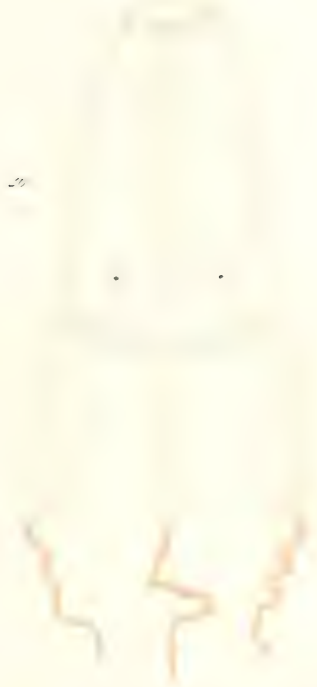
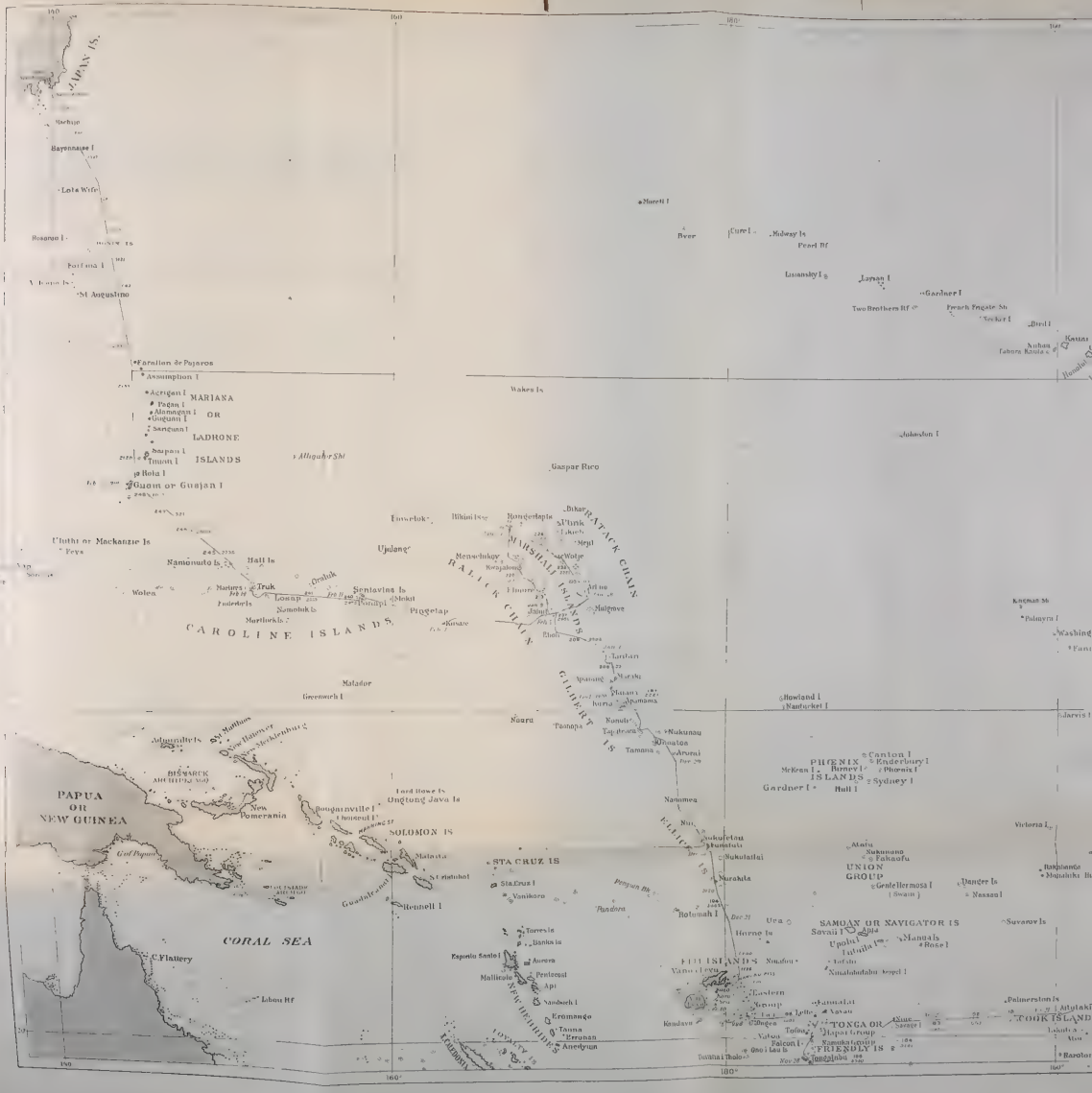
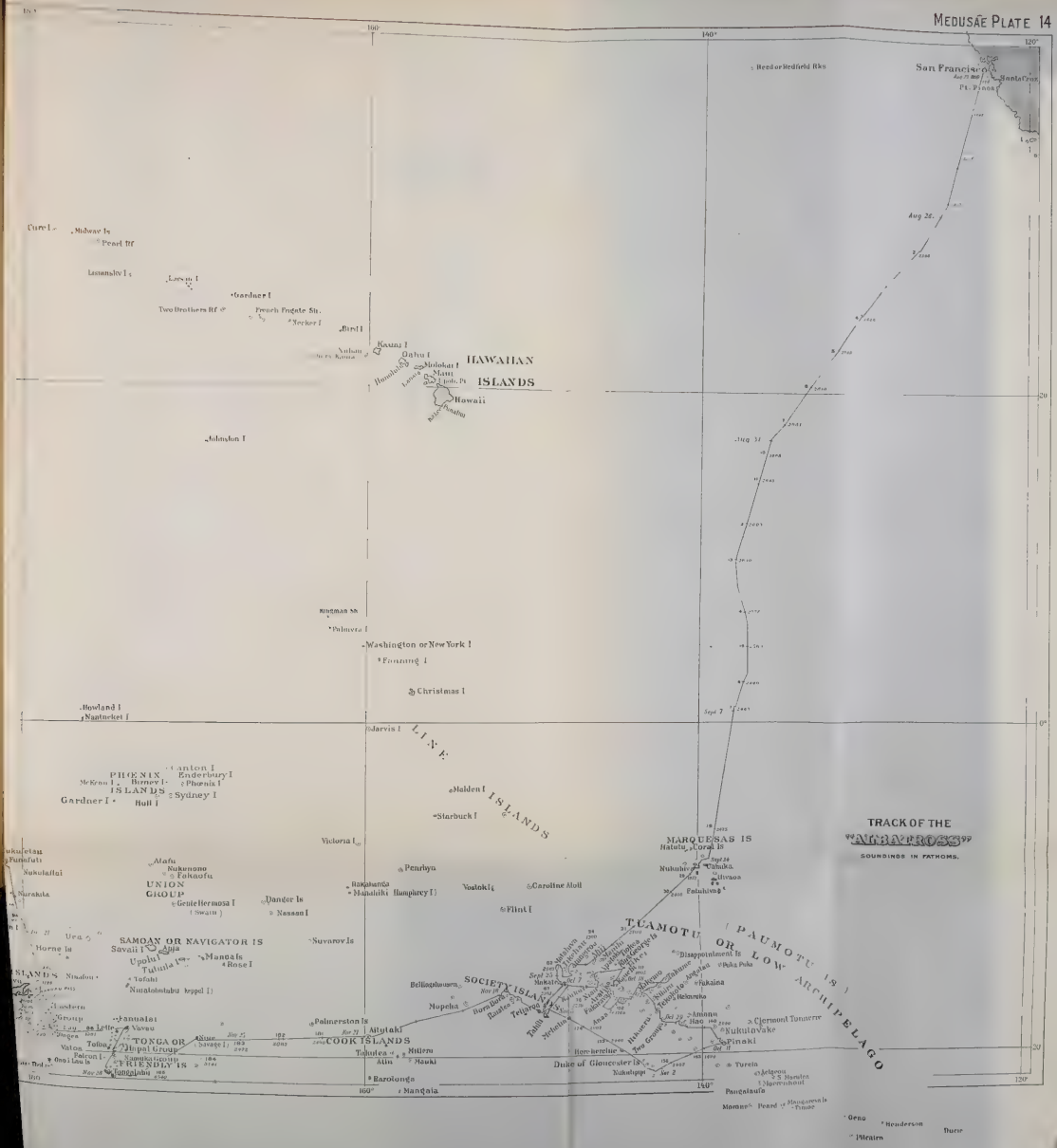


"ALBATROSS" TROPICAL PACIFIC EXPEDITION




TRACK OF THE "ALBATROSS"
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LINE ISLANDS
PHOENIX ISLANDS
SAMOAN OR NAVIGATOR IS
UNION GROUP
TONGA OR FRIENDLY IS
COOK ISLANDS
SOCIETY ISLANDS
TUAMOTU OR LOW ARCHIPELAGO
MARQUESAS IS
San Francisco
Santa Cruz
Pt. Pinos
Midway Is
Pearl Hr
Gardner I
Two Brothers Rf
French Frigate Sh.
Necker I
Bird I
Kauai I
Oahu I
Honolulu
Niihau I
Maui
Hawaii
Johnston I
Kingman Sb
Palmyra I
Washington or New York I
Fanning I
Christmas I
Howland I
Nantucket I
Jarvis I
Canton I
Enderbury I
Phoenix I
Sydney I
Hull I
Gardner I
Malden I
Starbuck I
Victoria I
Pearlys
Caroline Atoll
Flint I
Danger Is
Nassau I
Suvarov Is
Manua Is
Rose I
Tutuila
Tafahi
Niuafoobu
Savaii
Upolu
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Nukunono
Malu
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Genie Hermosa I
Rakahanga
Manahiki
Humphrey I
Penrhyn
Palmerston Is
Aitutaki
Mauki
Rarotonga
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Nukahiva
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Coral Is
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Disappointment Is
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Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXVI. No. 4.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, IN THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

V.

SHARKS' TEETH AND CETACEAN BONES

FROM THE

RED CLAY OF THE TROPICAL PACIFIC.

By C. R. EASTMAN.

WITH THREE PLATES.

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CAMBRIDGE, U.S.A.:
Printed for the Museum.
June, 1903.

Reports on the Scientific Results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., commanding.

V.

SHARKS' TEETH AND CETACEAN BONES FROM THE RED CLAY OF THE TROPICAL PACIFIC.

By C. R. EASTMAN.

(Published by permission of Geo. M. Bowers, U. S. Commissioner of Fish and Fisheries.)

When, more than sixty years ago, Edward Forbes sought to explain the so-called "Northern outliers" (or assemblages of marine animals inhabiting certain depressed areas of the sea-bottom in the vicinity of the British Islands, and differing from those found over adjacent and shallower regions) as remnants of a preglacial Arctic fauna, an ingenious suggestion was put forward, which subsequently received a wide application, and has indeed been carried to unwarranted extremes in some cases.

For instance, while there can be no question that Sir Charles Lyell was wrong in declaring that "to talk of chalk having been uninterruptedly formed in the Atlantic is as inadmissible from a geographical as a geological sense," and that Professor L. Agassiz's conclusion[1] is abundantly confirmed that "the present continental areas within the 200-fathom line, as well as the oceans, have preserved their outlines and positions from the earliest times," nevertheless the generalizations once so popular, that "we are still living in the Cretaceous epoch," or that "Cretaceous outliers" are represented by the archaic types still existing at great depths, are now accepted only in a very much modified sense.

Amongst the forms brought to light by dredging at great depths in mid-ocean which have interesting palæontological relations are semi-fossil sharks'

[1] Bull. Mus. Comp. Zoöl., Vol. I. (1869), pp. 368, 369.

teeth belonging to species characteristic of the middle or late Tertiaries in Europe and America, hence implying that these bodies have been lying on the sea-floor at least ever since the Pliocene, becoming buried with inconceivable slowness by the gradually accumulating sediment.[1] Large numbers of these teeth, together with hundreds of Cetacean bones, were obtained by the "Challenger" Expedition in 1875, all of them more or less impregnated with, and their substance sometimes entirely replaced by the oxides of iron and manganese. These accumulations of vertebrate remains are not limited to any one ocean, but are most abundant at extreme depths in the red clay areas of the central Pacific and other oceanic deposits, being only exceptionally found in calcareous oozes or telluric deposits. The "Challenger" collections were described in great detail by Murray and Renard in their Report on Deep-Sea Deposits,[2] published in 1891, which was the first attempt to deal systematically with deep-sea deposits and the geology of the sea-bed throughout the whole extent of the ocean. The Mammalian bones were still further investigated and described by Professor Sir William Turner.[3]

No additional material of this nature was obtained until Mr. A. Agassiz in 1880 dredged off the eastern coast of North America a few Cetacean bones and one or two sharks' teeth from the existing sea-bed at a depth of only 333 fathoms.[4] The teeth belonged to the genus Lamna, and differed from those dredged by the "Challenger" in that the root and vasodentine remained essentially unaltered, hence implying a comparatively recent

[1] The excessively slow rate of deposition of sediment in the central Pacific since the Glacial period is indicated by the unique assortment of continental rock fragments, coated with a thin layer of manganese, which was dredged by Mr. A. Agassiz in 1899 at Station 2 of the "Albatross" Expedition. *Cf.* Mem. Mus. Comp. Zoöl., Vol. XXVI. (1902), pp. 71, 110.

[2] *Murray, J.*, and *Renard, A. F.*, Report on Deep-Sea Deposits; Scient. Results "Chall." Exp. (1891), pp. 267–276. Chapter IV. of this volume, dealing with the materials of organic origin, was written wholly by Sir John Murray. Not more than four genera appear to be represented with certainty by the sharks' teeth, namely, Lamna, Oxyrhina, Carcharodon, and either Galeus or Carcharias; and owing to their imperfect condition, accurate specific determinations are in most cases impossible. Nevertheless, Mr. Murray regards these same organic remains, together with the associated manganese nodules, volcanic lapilli, and zeolitic minerals, as "by far the most interesting result of the dredgings between Tahiti and Valparaiso." (*Loc. cit.*, 1891, p. 181.)

[3] *Turner, W.*, Report on Bones of the Cetacea; Zoöl. "Chall." Exp., Vol. I. (1880), pt. iv., pp. 1–15.

[4] *Agassiz, A.*, Three Cruises of the "Blake"; Bull. Mus. Comp. Zoöl., Vol. XIV. (1888), p. 276. *Murray, J.*, "Blake" Deposits; *Ibid.*, Vol. XII. (1885), p. 42.

burial. It should be stated that in the great majority of the "Challenger" teeth, all that remains is the hard dentine or enamel, the root and whole of the vasodentine having been dissolved away.

During the years 1887–1889 extensive deep-sea dredging operations were carried on in the Indian Ocean by English and French hydrographers, the scientific results of which were discussed by Dr. Murray in two communications published in the Scottish Geographical Magazine.[1] Among the more striking features of these investigations was the discovery by Captain Pelham Aldrich in H. M. S. "Egeria" of semi-fossil teeth of sharks and earbones of whales, all more or less encrusted with peroxide of manganese, as had already been observed by the "Challenger" in similar areas of the Atlantic and Pacific. The author again calls attention to the fact that two of these species, *Carcharodon megalodon* and *Oxyrhina hastilis*, are characteristic of the middle Tertiaries, and, so far as known, are not now existing.

The most recent and only other source from which this class of organic remains has been derived is the "Albatross" Expedition of 1899–1900, which forms the basis of the present report. During this cruise vertebrate material was dredged from five stations in the Pacific, whose positions, depths, and bottom characters are given in the following table:[2]

List of "Albatross" Stations yielding Sharks' Teeth and Cetacean Bones.

Station Number.		Position.		Depth, Fathoms.	Nature of Bottom.	Number of Specimens	
A. Agassiz Serial.	"Albatross" Serial.	Latitude.	Long. W.			Fishes.	Cetaceans
		° ′	° ′				
2	3681	28 23 N.	126 57	2368	Red clay; light brown ooze.	153	15
13	3683	9 57 N.	137 47	2690	Red clay; light brown Rad. ooze.	58	7
17	3684	0 50 N.	137 54	2163	Grayish yellow Globigerina ooze.	1	0
173	3691	18 55 S.	146 32	2440	Red clay; volcanic mud.	6	0
183	3692	19 04 S.	167 41	2472	Red clay; Radiolarian ooze.	1	0
						219	22

[1] On some Recent Deep-Sea Observations in the Indian Ocean; Scottish Geog. Mag., Vol. III. (1887), pp. 553–567. On Marine Deposits in the Indian, Southern, and Antarctic Oceans; *Ibid.*, Vol. V. (1889), pp. 405–436. *Cf.* also Geol. Mag. [3], Vol. VI. (1889), pp. 514–517, Figs. 1–4.

[2] *Agassiz, A.*, Preliminary Report and List of Stations, with Remarks on the Deep-Sea Deposits by Sir John Murray; Mem. Mus. Comp. Zoöl., Vol. XXVI. (1902), pp. 1–114. *Cf.* also *Townsend, C. H.*, Dredging and other Records of the United States Fish Commission Steamer "Albatross," U. S. Fish Com. Rept. for 1900 (1901), pp. 387–562.

Comparison of Vertebrate Remains Dredged by the "Albatross" and "Challenger" Expeditions.

As the line run by the "Albatross" from San Francisco to Tahiti converges toward that run by the "Challenger" from the Hawaiian Islands to Tahiti, where the two cross, it is interesting to compare the results of deep-sea dredging accomplished on these voyages. On the run from San Francisco to Tahiti the "Albatross" made eleven deep-sea dredgings, four of which brought up sharks' teeth, as shown in the above table. On the course westward to the Fiji Islands, and thence northwesterly to Japan, three such deep-sea hauls were made, one of which (at Station 183, between Cook Islands and Tonga) yielded vertebrate remains.

Following the track of the "Challenger" from Yokohama, Japan, due east to the meridian passing through the Hawaiian Islands, and thence south to Tahiti, we find that eight stations are distributed along this route which yielded the same class of organic remains; but on the run from Tahiti to Valparaiso material of like nature was dredged at but one locality to the eastward of the Paumotu group, namely, at Station 293. The comparative paucity of vertebrate remains on the ocean-floor for a distance of 4,000 miles between parallels 30 and 40 of south latitude, as contrasted with their wide distribution and abundance elsewhere in the Pacific, is probably to be accounted for by the fact that this belt lies outside the south equatorial current, and that it has not been frequented by large sharks and Cetaceans since Tertiary times, or even longer. During the Tertiary, however, Carcharodons of enormous size ranged along the western coast of America from California to Patagonia, as is shown by their fossil remains.

Numerous Cetacean bones were dredged by the "Challenger" from the red clay in the vicinity of Tahiti (Stations 276–285), and it is regarded by Sir John Murray as rather surprising that none were in the material from the "Albatross" Station 173, which lies within the same area.[1] However, it is well known that the percentage of Mammalian remains brought up in the great majority of the "Challenger's" deep-sea dredgings was very small, and that, as Dr. Murray has himself stated,[2] "in all the terrigenous deposits

[1] Mem. Mus. Comp. Zoöl., Vol. XXVI. (1902), p. 110.

[2] Report on the Deep-Sea Deposits; Scient. Results "Chall." Exp. (1891), p. 270.

and calcareous oozes they were not observed." Furthermore, Mammalian remains brought up from the sea-floor are for the most part limited to bones of extremely dense structure, such as the ear-bones and fragments of the beaks of Ziphioid whales, the preservation of which is to be "accounted for by the great density of these portions of the skeleton, and the consequent small amount of surface presented to the action of the sea-water when compared with the cancellated bones."[1]

To our mind, the failure of the "Albatross" to bring up Cetacean remains at Station 173 is devoid of special significance, and does not affect the question of general distribution. More likely is the absence of such remains at this point, in close proximity to the Paumotus, to be explained as the result of local conditions affecting the solvent power of the sea-water.

The discovery of Cetacean bones by the "Albatross" at Station 2 in latitude 28° 23′ N., and also at Station 13 in north latitude of about 10°, is interesting, since no remains of this nature had been previously found north of the equator, in either the Atlantic or the Pacific. With the exception of two fragments, all the bones of Cetaceans procured by the "Challenger" Expedition were dredged from red clays and Radiolarian oozes, and "these were all situated in the central South Pacific, excepting Station 160, 2,600 fathoms, in the southern Indian Ocean, 500 miles southwest of Australia."

The general facts of distribution of sharks' teeth as observed by the "Challenger" Expedition are thus stated by Dr. Murray:[2] "The distribution of the sharks' teeth in the deposits is similar to that of the bones of Cetaceans, although they were dredged more frequently. They are most abundant in the red clay areas far removed from land, and especially in those of the central South Pacific; they were less frequently taken in the organic oozes of the deep sea, and only in one or two instances in the terrigenous deposits surrounding continental or other land. It seems undoubted that many of the teeth of sharks and the bones of the Ziphioid whales belong to Tertiary and extinct species."

To facilitate comparison, and to show at a glance the distribution, the following table has been prepared, which shows the position, depth, and

[1] *Loc. cit.*, p. 276.

[2] *Loc. cit.*, p. 276.

bottom characters of all the "Challenger" stations in the Pacific where sharks' teeth and Cetacean bones were obtained. At various other stations not included in this list, on the run from Hawaii to Peru, a few small teeth and otoliths of indeterminable fishes were brought up. Otoliths, on account of their dense structure and different chemical composition, are less readily destructible than other bones of the fish skeleton. Only in three or four instances were any fish bones, other than otoliths and teeth, observed in all the deposits brought to light by the "Challenger."

List of "Challenger" Stations in the Pacific yielding Sharks' Teeth and Cetacean Bones.

Station No.	Depth, Fathoms	Position.		Nature of Bottom.	No. of Specimens.		Remarks.
		Latitude.	Longitude.		Sharks.	Cetacea.	
		′	′				
237	1875	34 37 N.	140 32 E.	Blue mud.	Several.	0	
241	2300	35 41 N.	157 42 E.	Red clay.	1	0	Small Lamna tooth.
244	2900	35 22 N.	169 53 E.	Red clay.	1	0	" " "
248	2900	37 41 N.	177 04 W.	Red clay.	1	0	" " " [na.
252	2740	37 52 N.	160 17 W.	Red clay.	5	0	1 Carcharodon; 4 Oxyrhi-
256	2950	30 22 N.	154 56 W.	Red clay.	9	0	4 Oxyrhina; 5 Lamna.
274	2750	7 25 S.	152 15 W.	Reddish brown Radiolarian ooze.	Numerous.	13	2 Carcharodon; 9 Oxyrhina; 5 Lamna.
276	2350	13 28 S.	149 30 W.	Red clay.	250	16+	
281	2385	22 21 S.	150 17 W.	Red clay.	116	9	
285	2375	32 36 S.	137 43 W.	Red clay.	1500	50+	
286	2335	33 29 S.	133 22 W.	Red clay.	350	90+	
289	2550	39 41 S.	131 23 W.	Red clay.	1	5	Perfect Oxyrhina.
293	2025	39 04 S.	105 05 W.	Globigerina ooze, brown.	2	1	1 Carcharodon; 1 Oxyrhina.
299	2160	33 31 S.	74 43 W.	Blue mud.	0	1	Globicephalus.
					2236+	185+	

Synopsis of the Genera and Species represented in the Collection.

Of the rather over two hundred sharks' teeth dredged by the "Albatross," by far the greater number belong to the Lamnidæ, the only other family represented being that of the Carchariidæ. The five genera to which these teeth are referable with certainty may be arranged in order of their numerical abundance as follows: Oxyrhina, Lamna, Carcharodon, Carcharias, and Hemipristis. As already observed, the absence of the root and lateral denticles (in all cases where such were present) are serious obstacles to the precise identification of species, since the form and serration of the crown alone are not sufficiently distinctive characters. With

the exception of *Oxyrhina crassa* and *Carcharodon megalodon*, therefore, the specific determinations must be regarded as more or less provisional. It is interesting to note that the last two species became extinct in the Pliocene.

Oxyrhina Agassiz.

Oxyrhina crassa Agassiz.

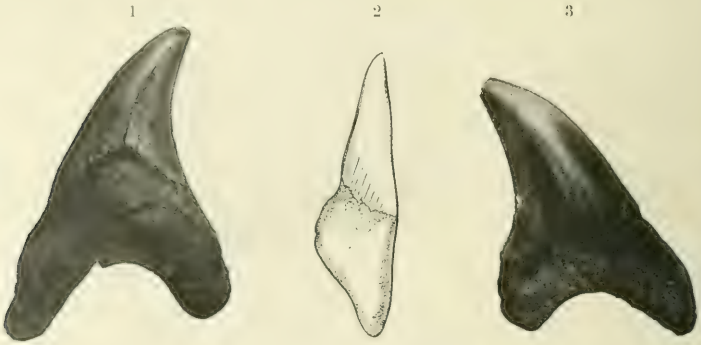
Plate 1, Figs. 11–20.

Over one hundred specimens of Oxyrhina teeth were obtained at Station 2, and about half that number from Station 13, which may be referred with little hesitancy to this species. Anterior and lateral teeth are represented in about equal proportions, the former signalizing themselves by their high and narrow crowns, not unlike those of the existing *O. spallanzani*, and the postero-lateral teeth only differing from those of *O. hastalis* in their considerable thickness. The outer coronal face is flat, the inner strongly convex, and the enamel smooth on both faces. The lower lateral teeth are triangular and erect; in those referable to the upper jaw the apex is sometimes lightly reflexed, and the crown often curved backward. All the teeth from Station 2 exhibit but a slight coating of manganese. The largest-sized anterior and lateral teeth which have been obtained of this species are shown in Figs. 13 and 19 respectively One nearly perfect crown, much perforated by sponge borings, was obtained at Station 17, and a fragmentary one at Station 183, both belonging to this species.

This species has not been recognized as such by the authors of the "Challenger" Reports, but unnamed Oxyrhina teeth evidently identical with those here described are illustrated in Pl. VI., figs. 8–11, 13–17, and 22. Of these only the ones shown in Figs. 14–16 are anterior teeth. Although numerous specimens of *O. hastalis* were dredged by the "Challenger," the "Albatross" Expedition was not fortunate enough to obtain any.

Oxyrhina crassa ranges from the Eocene to the Pliocene in Europe, and is of rare occurrence in the Phosphate Beds of South Carolina. The latter deposits, however, contain such an agglomeration of early and late Tertiary fossils that the age of the formation is indeterminate. No good figures of this species having been published heretofore from American localities, two perfect examples are shown in the accompanying text-figures, with which

the deep-sea crowns may be profitably compared. The originals are from the Phosphate Beds of Coosaw, South Carolina, and are preserved in the Museum of Comparative Zoölogy.



FIGS. 1–3. — *Oxyrhina crassa* Agassiz.

Phosphate Beds, Coosaw, S. C. Two lateral teeth referable to the upper jaw, one seen from the inner face and in profile (1, 2), the other showing the outer face (3). × ½.

Lamna CUVIER.

Lamna sp. ind.

Plate 1, Figs. 9, 10.

Twenty-two slender and sharply pointed teeth were obtained at Station 2, and one imperfect crown at Station 13, which belong to a small, indeterminable species of Lamna. These teeth have the outer face faintly and the inner very strongly convex, with smooth enamel on both sides. None of the specimens exceed 1.5 cm. in height. Similar teeth are figured in Pl. VI., figs. 12, 19, and 21 of the "Challenger" Reports, and are stated to occur plentifully in the Pacific.

Carcharodon MÜLLER AND HENLE.

Carcharodon megalodon AGASSIZ.

Plate 1, Figs. 21–23.

Fifteen comparatively small-sized teeth belonging to this species were brought up by the dredge at Station 2, and fragments of eight larger ones

at Station 13, these latter being quite heavily encrusted, and their substance impregnated with manganese. The most heavily encrusted of all, however, are six large teeth from Station 173 (Pl. 2, figs. 31–33), on which the deposit of manganese exceeds 1 cm. in thickness. The largest tooth anywhere obtained is from Station 13, its crown being preserved for a height of 7 cm.

This species enjoys the same range in the fossil state as *Oxyrhina crassa*, but is more cosmopolitan in distribution. In the Tertiaries of the Pacific coast it is known to have extended at least as far north as California, and teeth either of the same or a closely allied species occur in the Patagonian formation of Chubut.[1] A tooth in the Museum of Comparative Zoölogy from the Tertiary of Aria, Peru, has a total height of 13.5 cm., and a large upper lateral tooth from Coquimbo, Chili, described as *C. gigas* by Philippi,[2] was found in a deposit which has yielded teeth indistinguishable from those of the existing *C. rondeletti*.[3] The type-specimens of several of Professor Agassiz's species of Carcharodon are now preserved in the Museum of Comparative Zoölogy.

CARCHARIIDÆ.

Carcharias Cuvier.

Plate 1, Figs. 1–6.

The large family of Requiem Sharks comprises twenty or more recent genera and about sixty recent species, the latter being often closely related and difficult of determination. In many cases the detached teeth of Galeocerdo can only be doubtfully separated from those of certain species of Carcharias. The fossil forms having the teeth in both jaws all more or less serrated are usually placed in the subgenus Prionodon (Prionace); those having the upper teeth serrated at the base only, and the lower teeth erect and entire, in the subgenus Hypoprion. The serrated condition of the cor-

[1] *Woodward, A. S.*, Observations on Señor Ameghino's Notes on the Geology and Palæontology of Argentina, Geol. Mag. [4], Vol. IV. (1897), p. 22.

[2] Zeitschr. f. gesammt. Naturw., Vol. LI. (1878), p. 685, Pl. XIX.

[3] *Woodward, A. S.*, On Some Fish-remains from the Parana Formation, Argentine Republic, Ann. Mag. Nat. Hist., ser. 7, Vol. VI. (1900), p. 4.

FIG. 4.—*Carcharias* sp. ind. Station 2. Outer face of same specimen shown in Pl. 1, fig. 4. × 1.

onal margin is well shown in the accompanying text-figure 4, which represents the outer face of the same specimen as shown in Pl. 1, fig. 4. It is evidently with the group represented by Prionodon that five small serrated teeth from Station 2 and three somewhat similar ones from Station 13 belong, but a closer identification than this appears impossible. The narrow erect teeth shown in Pl. 1, figs. 1 and 5, are evidently anterior and lower in position, and those shown in Figs. 2, 3, 4, and 6 are by the same token postero-lateral teeth belonging to the upper jaw. The originals of Figs. 1–4 are all from Station 2, and possibly represent a distinct species from those shown in Figs. 5 and 6, which are from Station 13. All these teeth agree in their considerable thickness with certain Miocene species rather than with most existing forms.

Hemipristis Agassiz.

Plate 1, Figs. 7, 8.

This genus comprises several Tertiary and one still living species, the latter being an inhabitant of the Red Sea. The teeth are readily distinguishable from those of Galeus, Galeocerdo, Carcharias, and the like by the peculiar denticulation of their coronal margins. In Pl. 1, figs. 7 and 8, are shown two teeth belonging to an unidentified species of Hemipristis, both from Station 2. An enlarged view showing the serrations of the coronal margin is given in the accompanying text-figure 5. Two Hemipristis teeth were also obtained by the "Challenger" Expedition, and are figured in the volume on Deep-Sea Deposits, Pl. V., figs. 10 and 11. Figs. 8 and 9 of the same plate are probably of Carcharias teeth.

FIG. 5.—*Hemipristis* sp. ind. Station 2. Inner face of same specimen shown in Pl. 1, fig. 8. × 1.

TELEOSTEI.

The solitary evidence of bony fishes from the deep-sea deposits obtained by the "Albatross" is afforded by a small scapula brought up by the dredge from Station 2. The paucity of fish-remains, other than teeth and otoliths, has already been commented on as a striking fact, the explanation of which is probably to be sought in their different chemical composition and lesser density.

CETACEA.

Relatively few Cetacean remains are contained in the collection, fifteen specimens having been dredged at Station 2 and seven at Station 13. With the exception of several unrecognizable fragments, these consist of the tympanic and petrous bones of dolphins (Globicephalus or allied forms) and Ziphioid whales. The tympani and perioties usually occur in the detached condition, but in one or two cases they remain fused. None of these bones attain the size of the corresponding elements in *Globicephalus melas* of existing seas, and no large tympani of baleen whales, such as were obtained by the "Challenger" Expedition, are represented in the collection. Owing to lack of material for comparison, it is impossible to make more than approximate determinations. Several of the better preserved ear-bones are shown of the natural size in Pl. 2, figs. 25–29. In Pl. 1, fig. 24, and Pl. 2, fig. 30, is shown a peculiar bone of small size and dense structure, with three projecting prongs, which may perhaps be regarded as a Cetacean incus.

EXPLANATION OF PLATES.

PLATE 1.

(All figures are of the natural size.)

Figs. 1–4. *Carcharias* (*Prionodon*) sp. ind., Station 2. All of these specimens are seen from the inner or convex face; the original of Fig. 1 is an anterior lower tooth, and the remainder are postero-lateral teeth referable to the upper dentition.

" 5, 6. *Carcharias* (*Prionodon*) sp. ind., Station 13. Inner face of an anterior and an antero-lateral tooth of a small species possibly distinct from that illustrated in Figs. 1–4.

" 7, 8. *Hemipristis* sp. ind., Station 2. Inner face of two much decomposed crowns.

" 9, 10. *Lamna* sp. ind., Station 2. Two anterior teeth of a small species seen in profile and from the inner or posterior aspect.

Fig. 11. *Oxyrhina crassa* Ag., Station 2. Inner face of a small anterior tooth.

Figs. 12, 13. *Oxyrhina crassa* Ag., Station 2. Inner face of two large anterior teeth.

" 14–18. *Oxyrhina crassa* Ag., Station 2. Average-sized examples of the postero-lateral dentition.

Fig. 19. *Oxyrhina crassa* Ag., Station 13. Inner face of a large specimen belonging to the lateral series.

" 20. *Oxyrhina crassa* Ag., Station 2. A rather heavily encrusted lateral tooth corresponding in size to the anterior teeth shown in Figs. 12 and 13.

Figs. 21–23. *Carcharodon megalodon* Ag., Station 2. Rather lightly encrusted lateral teeth.

Fig. 24. Supposed Cetacean incus from Station 2; also shown in Pl. 2, fig. 30.

PLATE 2.

(All figures are of the natural size.)

Fig. 25. Right petrous bone of *Globicephalus* (?). Station 2.

" 26. Left tympanic and petrous bones still retained in natural association and apparently referable to *Globicephalus*. Station 13.

" 27. Left tympano-pteriotic of *Globicephalus* (?). Station 2.

" 28. Left petrous bone of a Ziphioid whale. Station 2.

" 29. Left tympano-pteriotic of a Ziphioid whale. Station 13.

" 30. Supposed Cetacean incus, also shown in Pl. 1, fig. 24. Station 2.

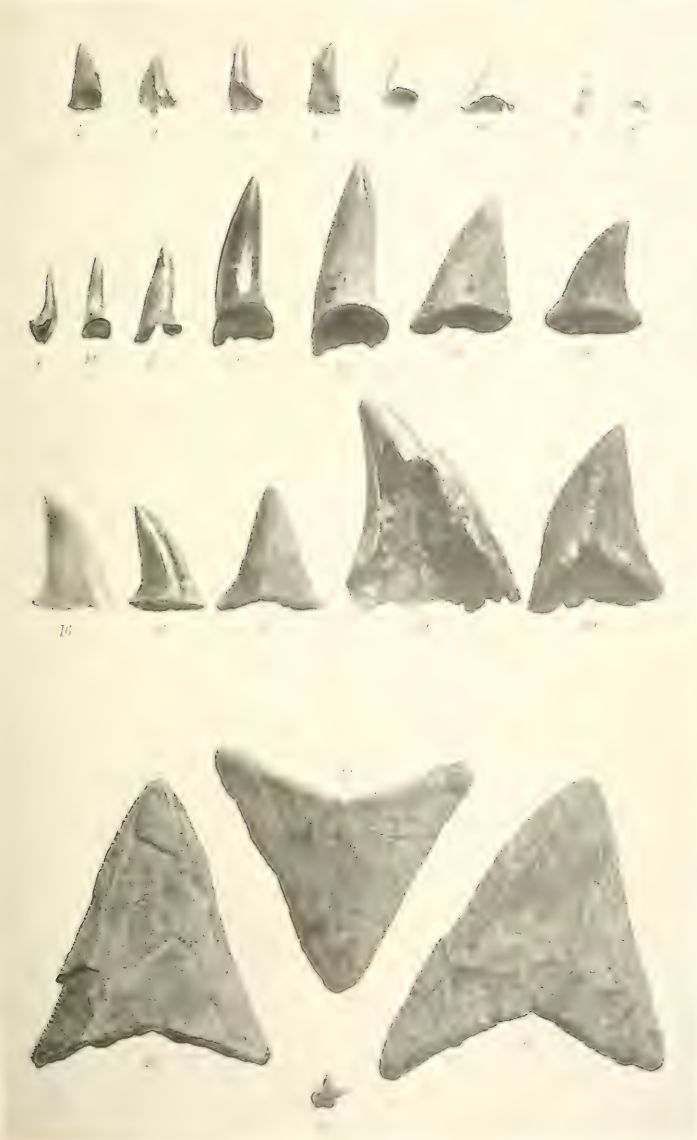
" 31. *Carcharodon megalodon* Ag., Station 173. A comparatively large-sized and very heavily encrusted specimen.

" 32. *Carcharodon megalodon* Ag., Station 173. A lateral tooth having a moderately thin coating of manganese on the outer face, and a very thick deposit on the inner, which presumably lay uppermost.

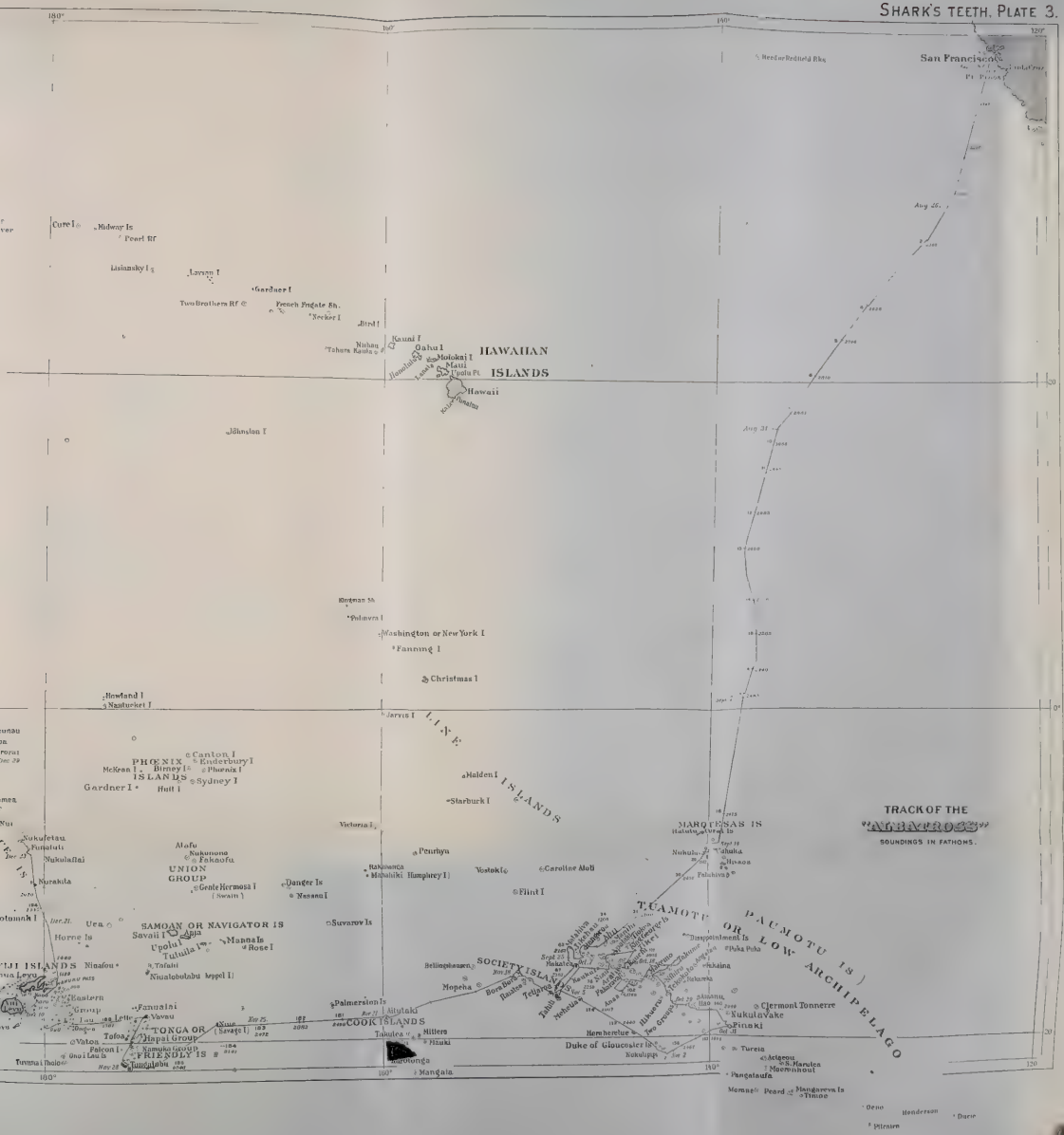
" 33. *Carcharodon megalodon* Ag., Station 173. A lateral tooth evidently buried in reverse position to that shown in the preceding figure.

PLATE 3.

Track of the "Albatross" from San Francisco to Yokohama.



"ALBATROSS" TROPICAL PACIFIC EXPEDITION.1899-00


San Francisco
Pt Pinos
Curve I
Midway Is
Pearl Rf
Lisianasky I
Lavson I
Gardner I
Two Brothers Rf
French Frigate Sh.
Necker I
Bird I
Nihau
Tahura Kauai
Kauai I
Oahu I
Molokai I
Honolulu
Lahaina
Maui
Upolu Pt
HAWAIIAN ISLANDS
Hawaii
Kealakeakua
Kawaihae
Johnston I
Aug 31
Elegnan Sh
Palmyra I
Washington or New York I
Fanning I
Christmas I
Rowland I
Nantucket I
Jarvis I
LINE ISLANDS
PHOENIX ISLANDS
McKean I
Birney I
Canton I
Enderbury I
Phoenix I
Gardner I
Hull I
Sydney I
Malden I
Starbuck I
Victoria I
TRACK OF THE "ALBATROSS"
SOUNDINGS IN FATHOMS.
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Tahuata
Hivaoa
Fatuhiva
Penrhyn
Vostok I
Caroline Atoll
Flint I
Rakahanga
Manihiki
Humphrey I
Danger Is
Nassau I
Suvarow Is
Nukufetau
Funafuti
Nukulailai
Nurakita
Mafu
Nukunono
Fakaofu
UNION GROUP
Gente Hermosa I
Swain I
SAMOAN OR NAVIGATOR IS
Savaii I
Upolu
Manua Is
Rose I
Tutuila
Tafahi
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Leppel I
Horne Is
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Alofi
Vavau
Eastern Group
Tongatabu Group
Falcon I
Namuka Group
FRIENDLY IS
Vatoa
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Ghat Lau Is
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Feb 21
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Nov 25
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Reports on the Scientific Results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

VIII.

THE PELAGIC TUNICATA.

By WILLIAM E. RITTER and EDITH S. BYXBEE.

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The occasion for the present paper was the request of Alexander Agassiz that the authors should examine the pelagic Tunicates secured by the "Albatross" during her cruise in the tropical Pacific from August, 1899, to March, 1900.[1] The material obtained on this voyage is the most interesting of any of the "Albatross" collections yet examined by us. The new Pyrosoma, which we take pleasure in inscribing to Mr. Agassiz, is especially interesting.

The collections upon which report is made have been brought together from many localities in the Pacific Ocean. By far the most important were made by the United States Fish Commission steamer "Albatross" on her many voyages since she first entered the waters of the Great Ocean in January, 1888.

Cyclosalpa bakeri Ritter.

Stn. 7 A.A., Sept. 1, 1899, Lat. N. 10° 19′, Long. W. 134° 57′, surface temp. 76°, surface net, 8 P.M. Two specimens, solitary generation, were taken.

[1] For a list of the Stations and a chart of the route see Memoirs M. C. Z., XXXVI., No. 1, January, 1902.

They were in a very bad state of preservation, in consequence of which the arrangement of the muscle bands, so characteristic of this species, could not be made out; however, the simple hypophysis mouth, and the longitudinal glands, make the identification reasonably certain.

Cyclosalpa affinis Chamisso.

Stn. 31 A.A., Sept. 19, 1899, Lat. S. 12° 20′, Long. W. 144° 15′, surface temp. 80°; taken in deepest part of channel separating the Marquesas from the Paumotu, 7 P. M. Two specimens of the solitary generation.

Stn. 2928, Jan. 23, 1889, off Southern California, Lat. N. 32 47′. Long. W. 118 10′, surface temp. 59°. Six specimens of the aggregate generation.

Salpa confoederata-scutigera Forsk. Cuv.

This species seems to be common off the coast of California and very variable. It is rare in the south seas. It was collected at four stations on these voyages.

Stn. 2928, Jan. 23, 1889, off Southern California, Lat. N. 32° 47′ 30″, Long. W. 118° 10′, surface temp. 59°. One specimen of the aggregate generation.

The test over the posterior part is much thickened and ridged, the ridges covered with papillae.

Stn. 2937, Feb. 4, 1889, off the coast of Southern California, Lat. N. 33° 04′ 30″, Long. W. 117° 42′, surface temp. 62°. A number of the aggregate generation of various sizes was collected.

All have the test much thickened over the viscera. The larger specimens have short processes scattered over this thickened portion, and a few over the soft anterior part.

Stn. 2946, Feb. 6, 1889, off Southern California, Lat. N. 33 58′, Long. W. 119° 30′ 45″, surface temp. 56.5°. A number of large chains.

The specimens are in such poor condition that no internal characteristics can be made out, but they seem to belong to this species.

Stn. 15 A.A., Sept. 8, 1899, Lat. N. 4° 35′, Long. W. 136° 54′, surface temp. 79°. A single young specimen of the solitary generation was collected on the surface.

Salpa democratica-mucronata Forsk.

This species was taken at two stations, both off the coast of Southern California.

Stn. 2928, Jan. 23, 1889, Lat. N. 32° 47′ 30″, Long. W. 118° 10′, surface temp. 59°. A number of both generations was collected. The solitary generation has very long, slender processes at the posterior end. In some cases these processes are almost as long as the body. In this particular they approach Traustedt's var. *flagelliferu*, but there is no other resemblance between the two.

Stn. 2937, Feb. 4, 1889, Lat. N. 33° 04′ 30″, Long. W. 117° 42′, surface temp. 62°. Both generations were collected, exactly similar to those taken at station 2928.

Salpa fusiformis-runcinata Cuv.-Cham.

This is the most common species in the collections. Large numbers of both generations were taken at different stations from the coast of Alaska to the South Pacific.

Stn. 2869, Sept. 21, 1888, Lat. N. 47° 38′, Long. W. 124° 39′, surface temp. 60°. Between Sitka and the Columbia River. Specimens in a very poor state of preservation.

July 12, 1887–88, Beaver Harbor (no such date given in printed records), British Columbia. There are a number of both generations bearing this label.

The test is somewhat thickened over the posterior part and provided with ridges.

Stn. "Sur. 35," 1887–88.

Stn. "Sur. 36,"[1] 1887–88.

[1] Mr. C. H. Townsend writes us as follows concerning these stations: "I think surface tow-net station No. 36 must certainly have been made immediately north of the Galapagos Islands. The surface tow-net records of that voyage were not printed in the 'Albatross' report for that year."

No record of these two tow-net stations can be found. From the nearest record it would seem that the "Albatross" was in the vicinity of the Galapagos Islands.[1] There are a large number of the aggregate generation in this collection.

Stn. 7 A.A., Sept. 1, 1899, Lat. N. 18° 19′, Long. W. 134° 57′, surface temp. 76°. A number of specimens of the solitary generation were taken at the surface, 8 P. M.

Stn. 12 A.A., Sept. 4, '99, Lat. N. 12° 07′, Long. W. 137° 18′. Surface temp. 81°. Four large specimens of the aggregate generation were collected between a depth of 150 fathoms and the surface. Two of them measure 6.5 cen. in extreme length and the smallest measures 4.5 cen. The test over the nucleus is much thickened and ridged, and the posterior processes show a tendency to become prismatic. Variations of this kind are mentioned by Herdmann as occurring in large specimens collected in the South Pacific by the "Challenger."

Stn. 14 A.A., Sept. 7, 1899, Lat. N. 6° 41′, Long. W. 137°, surface temp. 82°. One specimen of the solitary and three of the aggregate generation were taken on the surface at 8 P. M.

All of the aggregate generation have the anterior and posterior processes very short and bifurcated. Two of them have a short process at the level of the branchial orifice on the left side.

Stn. 15 A.A., Sept. 8, 1899, Lat. N. 4° 35′, Long. W. 136° 54′, surface temp. 79°. Two of the solitary and four of the aggregate generation were collected on the surface at 8 P. M.

All are more or less angular. Those of the aggregate generation have the serrate ridges strongly developed, and the test much thickened over the nucleus.

Stn. 31 A.A., Sept. 19, 1899, Lat. S. 12° 20′, Long. W. 144° 15′, surface temp. 80°. Two specimens of the solitary generation were taken on the surface, 7 P. M.

Stn. 89 A.A., Oct. 14, 1899, Lat. S. 16° 03.5′, Long. W. 145° 43′, surface temp. 80°. About one mile N. 28 W. of north entrance to Fakarava. Two specimens of the aggregate generation were taken between 350 fathoms and the surface.

[1] See note on page 197.

Salpa fusiformis-runcinata form echinata.

Two specimens of this form were taken on successive days not far from the equator.

Stn. 14 A.A., Sept. 7, 1899, Lat. N. 6° 41′, Long. W. 137°, surface temp. 82°. One specimen of the solitary generation was taken at the surface at 8 P.M. It is 6 cen. in length, 15 mm. in breadth near the posterior end and about 10 mm. at the anterior end. The chain of blastozooids is well developed.

Stn. 15 A.A., Sept. 8, 1899, Lat. N. 4° 35′, Long. W. 136° 54′, surface temp. 79°. One specimen of the solitary generation.

Salpa cylindrica Cuv.

Stn. 2928, Jan. 23, 1889. Off the coast of Southern California. Lat. N. 32° 47′ 30″, Long. W. 118° 10′, surface temp. 59°. A number of the solitary generation were taken.

Salpa tilesii-costata Cuv.-Quoy et Gaim.

Stn. 2928, Jan. 23, 1889. Off Southern California. Lat. N. 32° 47′ 30″, Long. W. 118° 10′, surface temp. 59°. A number of specimens apparently belonging to this species were collected. They are in very bad condition and only the general shape serves to identify them.

Stn. 236 A.A., Jan. 28, 1900. About forty-six miles southwest of south point of Arhno. Lat. N. 6° 34′, Long. E. 170° 59′, surface temp. 81°. Four specimens were taken on the surface by electric light. They are in very good condition. There are numerous sharp-pointed papillae scattered over the test of the dorsal side.

Salpa zonaria-cordiformis Pall-Quoy et Gaim.

Specimens of this species were collected at four localities:

Stn. 2 A.A., Aug. 27, 1899, Lat. N. 28° 23′, Long. W. 126° 57′, surface

temp. 66°. Four specimens of the aggregate generation were collected on the surface at night.

Three are about 1 cen. in length and have rather narrow muscle bands. One of these has the posterior extremity prolonged into a prominent process about 1 mm. in length. The fourth specimen is 2 cen. long and has much broader muscle bands than the other three.

Stn. 12 A.A., Sept. 4, 1899, Lat. N. 12° 07′, Long. W. 137° 18′, surface temp. 81°. One specimen of the aggregate generation was collected. It is 1.5 cen. in length, with a process at the posterior end measuring 5 mm.

Stn. 15 A.A., Sept. 8, 1899, Lat. N. 4° 35′, Long. W. 136° 54′, surface temp. 79°. One specimen of the solitary generation was taken at 8 P. M.

Stn. 31 A.A., Sept. 19, 1899, Lat. S. 12° 20′, Long. W. 144° 15′, surface temp. 80°.

One specimen of the solitary generation and four of the others have a short bifid process.

Salpa hexagona Quoy et Gaim.

This species was collected at three stations in the tropical Pacific.

Stn. 8 A.A., Sept. 2, 1899, Lat. N. 17° 13′, Long. W. 136° 09′. A single young specimen of the solitary generation was taken in the trawl, which had been down to a depth of 3088 fathoms. It measures 11 cen. in length, exclusive of the two posterior processes which are 1 cen. long, and is 3 cen. in breadth. This makes it almost exactly twice the size given by Traustedt in his description of the species. The processes, however, in Traustedt's figures are about $\frac{1}{5}$ the length of the body and are serrate. In this specimen the processes are only $\frac{1}{11}$ of the length of the body and are smooth. In all other respects the specimen agrees perfectly with Traustedt's figures.

Stn. 12 A.A., Sept. 4, 1899, Lat. N. 10° 57′, Long. W. 137° 35′, surface temp. 81°. Fifteen specimens of solitary generation were collected.

They are all young with a large part of the eleoblast still present. Their average length is 3 cen. and the processes at the posterior end are $\frac{1}{3}$ of the length of the body.

Sta. 12 A.A., Sept. 4, 1899, Lat. N. 10° 54′, Long. W. 137° 35′. Fifteen specimens of the aggregate generation were collected on the surface.

Their ridges are only slightly serrate.

Stn. 14 A.A., Sept. 7, 1899, Lat. N. 6° 41′, Long. W. 137°, surface temp. 82°. A single specimen of the solitary generation was taken on the surface at 8 P. M.

Pyrosoma giganteum Les.

Stn. 3474, Dec. 6, 1891, Lat. N. 21° 12′, Long. W. 157° 38′ 30″, Hawaiian Islands. Surface temp. 77°. Two specimens measuring respectively 8 cen. long and 5 cen. broad at closed end and 2 cen. broad at open end; and 6 cen. long and 2.5 cen. broad at open end; .9 cen. broad at closed end; colony narrowing abruptly toward closed end.

Pyrosoma atlanticum.

Stn. 14 A.A., Sept. 7, 1899, Lat. N. 6° 41′, Long. W. 137°, surface temp. 82°. Fourteen specimens were taken in the surface tow-net at 8 P. M. The largest measures 11.8 cen. in length, 2.7 cen. in greatest breadth, 2.4 cen. at the open, and 1.3 cen. at the closed end. The smallest measures 5.5 cen. in length, 1.3 cen. greatest breadth, .9 cen. at open, and .6 at closed end. All are of a beautiful clear shining white color.

Pyrosoma agassizi, sp. nov.

External Characters. Colony cylindrical, flaccid, 12 cen. long, 1 cen. broad in the middle, tapering very slightly toward both extremities. Surface covered with small quadrangular processes, 1 to 5 mm. in length, tapering abruptly from a broad base to an acute point; all curving toward the open end of the colony. Common atrial opening 6 mm. wide, guarded by four large processes of the test. These processes 6 mm. long, non-muscular, quadrangular, tapering to a blunt point; placed in pairs on opposite sides of the opening over which they curve. Test between

processes thin. Vessels carrying muscles running down into this thin test, Pl. I, fig. 1.

Test 3 mm. thick, gelatinous, transparent.

Zooids visible through the test, numerous, much flattened laterally, all placed with the dorsal edge toward the common opening of the colony, the larger zooids averaging 2 mm. long by 3 mm. broad. Young zooids and buds thickly scattered among the older zooids, Pl. I, figs. 2 and 3.

Mantle delicate. Muscles of the prebranchial zone well developed, especially one immediately above the peripharyngeal band. Atrial sphincter strong.

Branchial Apparatus. Branchial orifice at the base of a process of the test which curves over it, on the side toward the open end of the colony. Ventral tentacle present, also about twelve others; these slender and irregularly placed, varying in number and size in zooids of different ages. Branchial sac, with usually 20–26 stigmata on each side; 16 longitudinal bars on each side. Endostyle large, strongly curved. Dorsal languets, about six in number, very slender. Peripharyngeal band delicate, limbs not meeting on the dorsal side, but the two turning back and forming a broad angle, within which the dorsal tubercle is situated.

Ganglion large. Gland conspicuous; its duct long and bent near the middle; opening circular. Phosphorescent bodies large and prominent in the young zooids, becoming less conspicuous in the older ones, the cells composing them apparently decreasing in number and becoming somewhat scattered.

Digestive tract compact. Oesophagus short, funnel-shaped, entering the stomach near its middle. Stomach nearly globular. Rectum bent sharply back immediately on leaving the stomach and remaining parallel to it, Pl. I, fig. 4.

Atrial chamber small. Atrial orifice large, circular, furnished with a single tentacle on its dorsal edge; this tentacle long, somewhat flattened, abruptly tapering to an acute point, Pl. I, figs. 3 and 7.

Gonads not seen.

Buds. Every large zooid provided with a stolon bearing three buds, the largest of the buds with stolon well developed before it breaks loose

from the stolon by which it is produced. Branchial tentacles fewer in number and relatively much larger in young blastozooids than in older ones.

This species differs strikingly in external appearance from any of the described species of Pyrosoma, unless it be *P. spinosum*. The colony is more cylindrical than is usual, is very slender, and especially is altogether flaccid, the test lacking entirely the rigidity of that of *P. atlanticus* and *gigauteum*. The most noticeable external difference, however, is the character of the common cloacal opening.

Instead of the muscular diaphragm, which is a characteristic of all species, this one is provided with four non-muscular guarding processes. The test connecting these processes forms a very thin wall. The characteristic vessels bearing muscle fibres run from the zooids down into this wall of test and terminate there. No muscles could be detected in the processes themselves. The processes arise from bulb-like enlargements of the test about the common cloacal opening. These enlargements are somewhat wrinkled, as though by the movement of the processes, Pl. I, fig. 1. It would seem that such movement could only be caused by water currents, however. The spines covering the test of the colony resemble those described by Herdman for *P. spinosum*.

Turning to the interior of the colony, the shape of the zooids is characteristic. In all the previously known Pyrosomae, the mature zooid is elongated antero-posteriorly. In *P. agassizi*, however, all the zooids, young and old, are much broader than long, fig. 3. These proportions obtain also both for the branchial sac and the atrial chamber, as well as for the zooid as a whole. The branchial sac is one third broader than long. The atrium is at least four times as wide as deep. While no gonads have been found, the zooids seem to be fully developed in all other respects, but in no case was there found an appreciable departure from the proportions above given. The zooids are much flattened laterally.

The musculature resembles that of *P. spinosum*, which the species seems most nearly to approach. There are the usual muscles in the prebranchial region, and besides there is a strong sphincter just above the ganglion. Pl. II, fig. 6. The atrial sphincter is strong, especially under the atrial tentacle,

where it is at least three times as wide as elsewhere, fig. 7. Its nuclei are arranged in bunches running across the muscle and giving it a banded appearance, figs. 7 and 8. Under the atrial tentacle the nuclei are more irregularly scattered than elsewhere. The mid-atrial muscle is absent (?). At least a prolonged search has failed to reveal it. Its absence is probably correlated with the extreme shortness of the atrial chamber.

The oesophagus is cone-shaped, resembling that of *P. atlanticum*, but instead of entering at the end, it runs back in a fold of the stomach and enters it near the centre, fig. 4. The compactness of the whole digestive tract is characteristic. Instead of spreading across nearly the entire end of the branchial sac, it is confined to a space not much larger than the stomach. In fact, from the right side, only the stomach is visible, Pl. I, fig. 3. The digestive tract is situated a little to the dorsal side of the median line. Both the endostyle and row of dorsal languets approach it, and as a result curve around under the rows of stigmata. The endostyle is very strongly bent, fig. 3.

The peripharyngeal band is not closed on the dorsal side, but turns backward, forms a large angle about the dorsal tubercle, and extends along the dorsal side of the zooid — another point of resemblance to *P. spinosum*.

The large ganglion, Pl. II, fig. 6, has two large and two smaller nerves arising from its posterior end. At the anterior end there are two large ones and two pairs of smaller ones. The duct of the gland is long and bent near its middle.

The shape of the atrial chamber somewhat resembles that figured by Seeliger for young zooids of *P. atlanticum* var. *laevatum*. It is shallow and very broad, and the opening is large, figs. 2 and 3. The presence of the tentacle on its dorsal edge is distinctive, however. As is shown in Pl. II, fig. 7, this is formed of mantle alone. The test about the atrial orifice stops at its base. For a short distance on each side of it the mantle is much thickened. The edges of the tentacle are also thickened.

There does not seem to be as much difference as usual between the ventral tentacle and the other smaller branchial tentacles, Pl. I, fig. 3. This seems due both to the ventral tentacle being somewhat smaller and the others somewhat larger than usual.

There is only one specimen of this peculiar form in the collection. It was taken with the trawl, which had been down 830 fathoms, at Station 25 A. A. (in the vicinity of the Marquesas Islands) on Sept. 14, 1899, Lat. S. 8° 48′, Long. W. 139° 48′. Surface temp. 80°. Bottom temp. 38°.

It seems probable that, like *P. spinosum*, to which it is most nearly related, it is a deep-sea form. It resembles *P. spinosum* in the character of the spines covering the test and possibly in the character of the test itself, though descriptions of this structure in this latter species are meagre. It also resembles it in the arrangement of muscles about the branchial orifice and in the course taken by the peripharyngeal band. It differs in size, in the possession of an atrial tentacle, and probably in the shape of the zooid and in the character of the digestive tract.

It will probably appear to students of the pelagic Tunicata that the species here described is sufficiently distinct from any hitherto known Pyrosoma to deserve being regarded as the type of a new genus. This was the view held by us until a considerable collection of Pyrosomae recently came into our hands through the kindness of Professor C. H. Gilbert of the Leland Stanford Junior University, that was secured by the "Albatross" on her Hawaiian cruise during the summer of 1902. In this collection are several specimens identical with the colony here described, excepting that in some of them the four processes about the cloacal orifice are absent. We had regarded these as the most important characteristic of the new genus which it was our intention to establish. We consequently decided to adopt the more conservative course and, for the present at least, treat the new form as a highly distinct species of the old genus.

Species.	Station.	Date.	Latitude.	Longitude West.	Surface temp.	Depth.
			° ′ ″	° ′ ″	°	
Cyclosalpa bakeri	7 A. A.	Sept. 1, '99	N. 10 19	134 57	76	Surface.
C. affinis	31 A. A.	Sept. 19, '99	S. 12 20	144 15	80	Surface.
	2928	Jan. 23, '89	N. 32 47 30	118 10	59	
Salpa confœderata-scutigera . . .	2928	Jan. 23, '89	N. 32 47 30	118 10	59	
	2937	Feb. 4, '89	N. 33 01 30	117 42	62	
	2946	Feb. 6, '89	N. 33 58	119 30 45	66.5	
	15 A. A.	Sept. 8, '99	N. 4 35	136 54	79	Surface.
S. democratica-mucronata	2928	Jan. 23, '89	N. 32 47 30	118 10	59	
	2937	Feb. 4, '89	N. 33 01 30	117 42	62	
S. fusiformis-runcinata	2860	Sept. 21, '88	N. 47 38	124 39	60	
		July 12 '87–'88	Beaver	Harbor.		
	Stn. Sur. 35	" " '87–'88				Surface.
	Stn. Sur. 36	" " '87–'88				Surface.
	7 A. A.	Sept. 1, '99	N. 18 19	134 67	76	Surface.
	12 A. A.	Sept. 4, '99	N. 12 07	137 18	81	150 fathoms to surface
	14 A. A.	Sept. 7, '99	N. 6 41	137	82	Surface.
	15 A. A.	Sept. 8, '99	N. 4 35	136 54	79	Surface.
	31 A. A.	Sept. 19, '99	S. 12 20	144 15	80	Surface.
	89 A. A.	Oct. 14, '99	S. 16 03 5	145 43	80	350 fathoms to surface
S. fusiformis-runcinata form *echinata*.	14 A. A.	Sept. 7, '99	N. 6 41	137	82	"
	15 A. A.	Sept. 8, '99	N. 4 35	136 54	79	"
S. cylindrica	2928	Jan. 23, '89	N. 32 47 30	118 10	59	
S. tilesii-costata	2928	Jan. 23, '89	N. 32 47 30	118 10	59	
	236 A. A.	Jan. 28, 1900	N. 6 34	E 170 59	81	
S. zonaria-cordiformis	2 A. A.	Aug. 27, '99	N. 28 23	126 57	66	Surface.
	12 A. A.	Sept. 4, '99	N. 12 07	137 18	81	
	15 A. A.	Sept. 8, '99	N. 4 35	136 54	79	
	31 A. A.	Sept. 19, '99	S. 12 20	144 15	80	Surface.
S. hexagona	8 A. A.	Sept. 2, '99	N. 17 13	136 09	78	3088 fathoms (?)
	12 A. A.	Sept. 4, '99	N. 10 57	137 35	81	
	14 A. A.	Sept. 7, '99	N. 6 41	137	82	Surface.
Pyrosoma giganteum	3474	Dec. 6, '91	N. 21 12	157 38 30	77	
P. atlanticum	14 A. A.	Sept. 7, '99	N. 6 41	137	82	Surface.
P. agassizi	25 A. A.	Sept. 14, '99	S. 8 48	139 48	80	830 fathoms Bottom temp. 38°.

Oikopleura huxleyi (Huxley) Ritter.

Syn. **Appendicularia flagellum** Huxley.

There is almost no doubt that the species before us is the *Appendicularia flagellum* described by Huxley in 1851, though unfortunately the material at hand is not adequate in either quantity or quality to enable us to reach absolute certainty on the point.

Length of body of largest specimens 2 mm.+; length of tail 7 mm. to

10 mm.; maximum width of tail 1.75 mm. Anterior two thirds of body nearly cylindrical, posterior, visceral third considerably larger.

Tail broadest a short distance behind its attachment and gradually narrowing from here to its long, pointed extremity. Notochord rather thick, though scarcely visible through the highly developed musculature. Muscle layer considerably broader on each side of the notochord than the notochord itself, and leaving but a narrow band between its outer edge and the margin of the tail, unoccupied by muscle.

Branchial orifice very large, elliptical, regular in outline excepting for a broad, short process on its ventral side.

Hypophyseal organ large, cone-shaped, the base of the cone directed ventrally and somewhat backward. Extremely long and strong cilia within the duct, situated on some of the cells at the basal end, and extending up into the apex.

Ganglion considerably smaller than the hypophyseal organ, and apparently connected with the apical end of the latter. *Otocyst*, with its contained *otolith*, rather small and indistinct.

Peripharyngeal band broad, its dorsal limbs reaching far back behind the ganglion and hypophyseal organ.

Endostyle typically very large and conspicuous, owing to the great development of the four series of gland cells.

Oesophagus curved to nearly a semicircle so as to enter the dorsal side of the stomach. *Stomach* large, left lobe much larger than the right, the former rounded-quadrilateral in outline as seen from the left side, the antero-ventral angle extended into a broad coecum which reaches down along the left side of the rectum. Right side scarcely developed into a true lobe. Intestine arising from the right side, running forward, with a sharp bend toward the median line near its middle, then extending on forward in a nearly straight course to terminate close under the posterior end of the endostyle. *Sexual organs*, situated on the postero-ventral side of the stomach, small in all the specimens seen, hence not recognizably composed of male and female elements; apparently consisting of a single compact mass.

The "house," the *gill openings* and the *integumentary glands* alongside the anterior end of the endostyle, we have not found, none of the specimens

being well enough preserved, probably, to show the last two structures. Furthermore, we are unable to give any definite information about the different areas of oikoplast epithelium distinguished by Lohmann, 1896, and other writers. Along the dorsal side of the body Pl. II, fig. 9, occurs a band of epithelium with distinct, cuboid cells that may be "membranophasts."

The absence of the enormous secreting cells situated on each side of the body, well toward the anterior end, and constituting what is called by Lohmann the "oval" has surprised us not a little. We were at first inclined to interpret the endostyle, or rather the great gland cells in it, as being these organs; but microtomic sections of the body revealed at once the erroneousness of this conjecture.

The gland cells of the endostyle, fig. 9, are apparently quite similar in size, structure of the cell body, and size and form of the nucleus, to those of the "oval." In none of the species of the genus hitherto described do we find special reference to the great development of the gland cells of the endostyle, though in some, e.g., *O. intermedia*, it appears from the figures of Lohmann, 1896, they do become much like those here described. Again, Salensky, 1903, in his recently published detailed anatomical study of *O. vanhoffeni*, speaks of the organ as being constituted "de grosses et hautes cellules glandulaires." We are unable, however, to recognize an anterior as distinguished from a posterior part of the organ in any such definite way as is described and figured by Salensky. There are, it is true, a few cells at the extreme anterior end, somewhat larger than those of the rest of the organ, fig. 9; but that they are different in character or relation is not obvious. We count about twenty of the large cells in each of the four series. Their nuclei are nearly perfect spheres, regular in outline, and considerably clearer than is the cell body. They are situated at the extreme outer ends of the cells. It should be mentioned that our description of the endostyle is made chiefly from specimens examined in toto, sectionized material not being sufficient to enable us to do much more than make out definitely that the large cells belong to the organ. We do not wish to be understood as casting doubt on Salensky's interesting observation relative to the anterior and posterior coeca of the endostyle, both communicating

with the pharynx through a common small orifice. We mean only that, examined in toto, the presence of these coeca is not recognizable in our specimens.

Although Huxley's work on Appendicularia is so admirable from the point of view of general morphology, many of the details, upon which the present-day characterization of species and genera rests, he touched very meagrely or not at all. For example, the glandular areas by which the "House" is secreted, the "oikoplast" epithelia of Lohmann, he knew nothing about. In fact his studies on *Appendicularia flagellum* were made without his coming in contact with the "house" at all. Likewise his description of the intestinal tract is rather too meagre to satisfy the importance that this structure has assumed for purposes of classification at the hands of recent students of the group.

These deficiencies in Huxley's description and the incompleteness of our own data render the identification of the two forms as one and the same somewhat less certain than could be wished; nevertheless it is, we believe, justified by the following readily recognizable similarities: The two are essentially of the same size and dimensions (compare the measurements of our specimens given above with the size diagram marked "N. S." in Huxley's Pl. XVIII). This fact will be seen to have special importance when attention is called to the further fact that the length of the tail in this species is nearly three times that of the next largest species of the genus excepting *O. cophocerca*, which it just about equals.

The general outline of the body (compare fig. 9 with Huxley's Pl. XVIII, fig. 1, and fig. 2) of the two forms is essentially the same, and would seem to be rather sharply differentiated from most other species by the relatively large diameter of the anterior end to accommodate the unusually large branchial orifice, or mouth. The great length of the rectum and the far forward position of the anus in both forms is another apparently common characteristic.

Again, the tails agree in being narrowly pointed at the posterior end in both forms, and while this is not an exclusive character, the tails of so many of the other species of the genus are of some other form that considerable weight attaches to this similarity.

Finally the part of the world from which the two animals come supports the view that they are the same. They are both from the South Pacific. Huxley's specimens were taken on the coast of New Guinea, situated in Lat. 0° to 10° S. and Long. 132° to 152° W., while the specimens under consideration in the present paper are from Station 16 A. A. Lat. 2° 38′ N., Long. 137° 22′.

There are two points only in which the information at hand seems to indicate rather important differences between the two forms. Huxley says "a very distinct spherical auditory sac" is attached to the ganglion, and his figures indicate still more distinctly than do his words that this structure is much larger than it seems to be in our specimens. We assume, however, that the difference is due to the fact that Huxley studied living animals, while we have, of course, been able to examine only preserved ones and rather poorly preserved ones at that.

The other seeming difference is in the musculature of the tail. Huxley's figures certainly do not indicate as wide a band of muscle on each side of the notochord as is present in the specimens examined by us. As shown in fig. 11, there is almost no muscleless zone between the outer border of the muscle and the margin of the tail, while Huxley's figures show a wide zone of this kind. So far as this fact by itself is concerned, we might suppose the difference to be due again to shrinkage in preservation suffered by our specimens. It seems, however, that the muscle bands in our specimens are broader *relatively to the notochord* than is Huxley's, and it is not apparent that shrinkage could account for this. However, we cannot believe that in view of the many strong resemblances this one apparent difference should have much weight.

It remains to say a few words concerning the name of our species.

The name *Appendicularia flagellum* applied by Huxley, not only to his New Guinea specimens, but also to all the Appendicularians subsequently studied by him, he adopted from Chamisso, who had given it in 1821 to an animal taken by him "near Behring Sea." Oikopleura was proposed by Mertens in 1831 for an animal discovered in the same region, and called by him *O. chamissonis*. Neither Chamisso nor Mertens defined their genera with much accuracy, Chamisso being especially brief and general in his

description. No serious attempt was made to establish the genera of the group on a secure foundation until Fol published his important memoir in 1872. This author satisfied himself of the generic distinctness of the species studied by Chamisso and Mertens, and gave an exact definition of Oikopleura. Fol's treatment of the subject has been accepted by all subsequent writers. There can, it would seem, be no question, then, that our species is an Oikopleura and not an Appendicularia, as these genera are now understood. The important and somewhat difficult question to be answered is should the specific name *flagellum* stand?

Most recent writers have regarded *flagellum* as a *nomen nudum* so far as Chamisso's description is concerned. It would be permissible, by the recognized rules of nomenclature, for us to take this view of the matter, to then consider the name as re-established and adequately defined by Huxley, and so to retain it as Huxley's not Chamisso's. There is, however, the practical objection to this that future research may discover that the name will have to stand for the animal to which Chamisso applied it. We have consequently thought it wiser to name the species anew, and certainly no more fitting name could be selected than that of the famous zoölogist who first recognized and made clear the place of Appendicularia in the zoölogical scale.

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ABBREVIATIONS.

A. S.	Atrial sphincter muscle.
A. T.	Atrial tentacle.
B. mus.	Branchial siphon muscle.
D. L.	Dorsal languets.
D. T.	Digestive tract.
End.	Endostyle.
Es.	Esophagus.
Gang.	Ganglion.
Gon.	Gonad.
L. B.	Longitudinal bars of branchial sac.
L. lo. st.	Left lobe of stomach.
M.	Mantle.
N.	Nerves from ganglion.
O.	Orifice of hypophyseal duct.
P. B.	Peripharyngeal band.
P. O.	Phosphorescent organ.
R. lo. st.	Right lobe of stomach.
S.	Branchial stigmata.
S. O.	Duct of subganglionic gland.
St.	Stolon.
St. f. B.	Bud still attached to stolon.
Sub. Gl.	Subganglionic gland.
T.	Test.
Ten.	Atrial tentacle.
Tl.	Tail.
V. T.	Ventral tentacle of branchial circle.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Pyrosoma agassizi*, shows the open end of the colony, with the four processes around the orifice.

Fig. 2. " " three nearly adult zooids, looked at on the posterior side; *i. e.*, the side of the atrial orifice, and each with a stolon and two younger zooids.

Fig. 3. " " a single zooid seen from its right side.

Fig. 4. " " the intestinal tract, with a portion of the branchial sac, and of the posterior end of the endostyle.

Fig. 7. " " the atrial tentacle and the atrial sphincter muscle, with its groups of nuclei.

PLATE II.

Fig. 5, *Pyrosoma agassizi*, the circle of branchial tentacles, showing the larger ventral one.

Fig. 6. " " the ganglion and hypophyseal gland and adjacent structures, seen from the inside.

Fig. 8. " " an enlarged view of one of the groups of nuclei of the atrial sphincter muscle.

Fig. 9. *Oikopleura huxleyi*, the body of the animal, seen from the right side.

Fig. 10. " " the intestinal tract and gonad, seen from the ventral side.

Fig. 11. " " the tail.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXVI. No. 6.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

X.

THE LANTERN FISHES.

By CHARLES HENRY GILBERT.

WITH SIX PLATES.

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CAMBRIDGE, U. S. A.:
Printed for the Museum.
July, 1908.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in Charge of Alexander Agassiz on the U. S. Fish Commission Steamer "Albatross" from August, 1899, to March, 1900, Commander Jefferson T. Moser, U. S. N., commanding.

X.

THE LANTERN FISHES.

By CHARLES HENRY GILBERT.

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The collections, which form the subject of the present paper, were made by the "Albatross," during the month of September, 1899, on a cruise from San Francisco to the Marquesas Islands and thence to Tahiti of the Society Islands. Frequent hauls were taken with the surface net and the open intermediate net to a depth of 300 fathoms. Fifteen species of Lantern Fishes were obtained, five of which are described as new, the others being known variously from Australia, the China Seas, Hawaii, the Pacific Coast of tropical America, or Southern California. One species is known also from the Eastern Atlantic. A very wide distribution is thus shown for the pelagic fishes of the tropical Pacific.

Myctophum affine (Lütken).

Scopelus affinis Lütken, Spolia Atlantica, 1892, **2**, p. 32.
Myctophum nitidulum Garman, Mem. Mus. Comp. Zoöl., 1899, **24**, p. 266, pl. 56, fig. 3.
Rhinoscopelus oceanicus Jordan and Evermann, Bull. U. S. Fish Com., 1903, **22**, p. 168.
Myctophum margaritatum Gilbert, Bull. U. S. Fish Com., 1905, **23**, p. 596, pl. 68, fig. 2.

Direct comparison of types has failed to develop any differences between *Myctophum affine* from the Atlantic and *M. nitidulum*, *M. oceanicum*, and *M. margaritatum* from the Pacific. The oldest name, *affine*, is here used.

The species has been shown to be abundant throughout the Hawaiian Group as far to the west as Laysan Island and as far to the northeast as Lat. N. 28° 13′ 42″, Long. W. 145° 44′. The present collection extends the

range from this point almost directly south to the Marquesas Islands, as is shown by the following list of stations:

Lat. N. 17° 32′	Long. W. 135° 40′
10° 57′ 35″	137° 35′ 25″
3° 28′	136° 54′
1° 45′	137° 36′
Marquesas Islands (approximately) Lat. S. 9°	Long. W. 139° 45′

Throughout this extensive area, the species shows a striking uniformity. The photophores are invariable in number and position, except in the anal series. For comparison with the extensive Hawaiian collections previously reported, we give below the variation in the antero- and postero-anals in the 17 specimens of the present collection, the two sides of each specimen being listed separately: Antero-anals, 8 in 9 cases, 9 in 23 cases, 10 in 2 cases; postero-anals, 5 in 21 cases, 6 in 13 cases; 8 + 5 occurs in 4 cases, 8 + 6 in 5, 9 + 5 in 15, 9 + 6 in 8, 10 + 5 in 2. The three specimens from Lat. N. 10° 57′ 35″, Long. W. 137° 35′ 25″ have the numbers $\begin{matrix}8+6\\8+6,\end{matrix}$ $\begin{matrix}8+5\\8+5,\end{matrix}$ $\begin{matrix}8+5\\8+5,\end{matrix}$ thus averaging one less than the others in this collection and in that from the Hawaiian Islands.

In the type of *M. nitidulum*, the anals are 8 + 5 on one side, 8 + 6 on the other.

Myctophum evermanni Gilbert.

Bull. U. S. Fish Com., 1905, **23**, p. 597, pl. 70, fig 2.

Eleven specimens from the following localities:

Lat. N.	Long. W.
17° 32′	135° 40′
10° 57′ 35″	137° 35′ 25″
5° 49′	136° 47′
Lat. S.	
16° 39′	149° 11′

The range is thus extended from the Hawaiian region directly south to beyond the Marquesas Islands. No differences are evident in the southern specimens, so far as the limited material is adequate to determine that point. The usual number of anal photophores is 8 + 5, which occurs bilaterally in

5 specimens and on one side of 3 others; 9 + 5 occurs bilaterally in 1 specimen, 8 + 6 bilaterally in 2; 7 + 5 occurs unilaterally in 3 specimens.

This species has been compared with specimens of *M. humboldti* and *M. californiense* and is very distinct from both.

Myctophum reinhardti Lütken.

Scopelus reinhardtii Lütken, Spolia Atlantica, 1892, **2**, p. 257, fig. 16.

Myctophum atratum Garman, Mem. Mus. Comp. Zoöl., 1899, **24**, p. 268.

Myctophum braueri Gilbert, Bull. U. S. Fish Com., 1905, **23**, p. 598, pl. 70, fig. 1; not **Myctophum (Lampanyctus) braueri** Lönnberg, Zoöl. Anz., 1905, **28**, p. 764.

Six young specimens from near the equator, Lat. N. 1° 45′, Long. W. 137° 36′. The anals number 11 to 13 instead of 13 to 15, as in Hawaiian specimens. The following combinations are present: 6 + 7 in 5 cases, 6 + 6 in 3, 5 + 8 in 1, 5 + 7 in 1, 5 + 6 in 2. As in *D. spinosus*, the southern specimens show a lower average number of photophores, but the limited amount of the material makes the comparison inadequate. The type of *M. atratum*, from near the entrance to the Gulf of California, was in rather poor condition, so the number of posterior anals could not be determined with certainty. Six can be made out on one side of the type specimen and 5 on the other, but others may have been present in life.

Lütken's account of *M. reinhardti* as having 11 dorsal and 16 anal rays and with antero-anal photophores varying from 4 to 7, seemed to indicate a species distinct from this Pacific form. Examination of the two specimens which Lütken designated as types shows, however, that they represent two very distinct species. The one figured by him, from 34° 22′ N. Lat., 18° 10′ W. Long., may be considered the type, and has 14 dorsal and 24 anal rays, as in *M. atratum*. On direct comparison with the latter no important differences appear. Lütken's fin-counts were taken from his second specimen, which belongs to a species still undescribed.

Dasyscopelus spinosus (Steindachner).

Scopelus spinosus Steindachner, Sitz. akad. wiss. Wien, 1867, **55**, p. 711, pl. 3, fig. 4.

Twenty specimens of this species were obtained at the following localities:

Lat. N. 13° 32′	Long. W. 135° 40′
Lat. N. 3° 28′	Long. W. 136° 54′
Lat. S. 15° 24′ 30″	Long. W. 147° 59′ 40″
Lat. S. 16° 39′	Long. W. 149° 11′

The number of individuals is too limited for satisfactory comparison with Hawaiian material. The photophores of the anal series are present in numbers as follows: 7 + 5 in 4 cases, 7 + 6 in 20, 7 + 7 in 9, 6 + 6 in 3, 6 + 7 in 3, 6 + 8 in 1. Thus in the anterior group, 7 occurs in 33 cases, 6 in 7 cases; in the posterior group 8 occurs in 1 case, 7 in 12 cases, 6 in 23 cases, and 5 in 4 cases. Comparing these with data given for Hawaiian material (Bull. U. S. Fish Com., 1905, **23**, p. 599), it appears that the more southerly specimens average one less photophore in the anal series. The total number varies from 12 to 14, 13 prevailing, while in Hawaiian material the range was from 13 to 15 with 14 prevailing. In the southern material, the number 8 is absent from the anterior group, and 6 occurs not infrequently, while in Hawaiian species, 8 is common and 6 very rare. A similar difference is found in the posterior group.

The serrations on the scales are very evident in specimens 30 mm. long, but are not apparent in those 20 mm. long. The serrations develop first on the scales along the dorsal profile behind the dorsal fin.

Dasyscopelus pristilepis Gilbert & Cramer.

Gilbert & Cramer, Proc. U. S. Nat. Mus., 1897, **19**, p. 412, pl. 39, fig. 1; Gilbert, Bull. U. S. Fish Com., 1905, **23**, p. 600.

Three young specimens from the following stations:

Lat. N. 1° 45′	Long. W. 137° 36′
Lat. S. 16° 39′	Long. W. 149° 11′

In the number of anal photophores 7 + 4 occurs bilaterally in one specimen, 7 + 5 bilaterally in another, 7 + 4 and 7 + 5 in the third.

Dasyscopelus asper (Richardson).

Myctophum asperum Richardson, Ichth. Erebus & Terror, 1845, p. 41, pl. 27, figs. 13–15.

Four specimens not exceeding 20 mm. long, taken at the surface Sept. 8, 1899, in Lat. N. 3° 28′, Long. W. 136° 54′, about 700 miles north of the Marquesas Islands.

Most nearly related to *Myctophum pristilepis*, Gilbert & Cramer, from the Hawaiian Islands, differing in the higher, more compressed head, the blunter, somewhat projecting snout, the much smaller eye, which is far below the upper profile, the more angulated supra-anals, and the slightly more distant precaudals. The number of anal photophores is larger.

Measurements in hundredths of length to base of caudal: length of head 32; eye 9; axial length of snout 4.5; greatest depth of body 26; least depth of caudal peduncle 9; distance from snout to front of dorsal 46; to base of ventrals 47; to front of anal 62; to adipose dorsal 82.

Dorsal 13, anal 17, pectoral 15, lateral line 37.

Head and body comparatively deep and compressed, eye small, well below the upper profile, snout high and compressed, slightly protruding beyond premaxillaries. Maxillary little widened posteriorly, extending beyond eye a distance less than half orbital diameter. Teeth all straight, in very narrow bands, consisting of a series of somewhat longer teeth with smaller ones interspersed. Cheeks not oblique, the posterior border of preopercle vertically rounded.

Pectorals long, extending to or slightly beyond middle of ventrals; ventrals reaching vent, inserted a trifle behind origin of dorsal; first anal ray under the last of the dorsal, its last rays under the adipose fin.

Scales mostly fallen, those present showing a few coarse serræ. Two minute antorbital photophores, one above the other below level of nostrils, the two connected by a narrow black bar. Supra-pectoral slightly nearer pectoral fin than lateral line; upper infra-pectoral opposite base of lower pectoral ray, the lower infra-pectoral nearer the upper than the first pair of ventrals. First pair of ventral photophores nearest the median line, the second, third, and fourth pairs nearly equidistant from it, the fifth pair

more divergent, but not markedly so; interval between third and fourth pairs shortest, that between fourth and fifth but slightly longer; second interval but little shorter than the first. Supra-ventrals slightly nearer ventral fins than lateral line. First pair of ventral photophores nearly in contact on median line, the others farther apart and equidistant from median line, the fourth pair at the sides of the vent and somewhat anterior to it; second interval longest, the first shortest. Upper supra-anal immediately below lateral line on its seventeenth scale, and in a vertical line passing through the second anal ray; middle supra-anal slightly nearer upper supra-anal than fourth ventral, in an oblique line joining the two; lower supra-anal below and well in advance of middle supra-anal, in a line joining middle supra-anal with first ventral. Antero-anals 7 (6 in one specimen), equally spaced, forming a gently curved line with the concavity downwards. Postero-lateral immediately below lateral line, above or slightly behind last antero-anal. Postero-anals 5. Precaudals 2, in an oblique line, the interspace a little wider than that separating those of anal series.

In the four specimens before us, the anal photophores number as follows:

$$\begin{matrix} \{7+5 & \{7+5 & \{7+5 & \{6+5 \\ \{7+5, & \{7+5, & \{7+4, & \{6+5 \end{matrix}$$

General color very light brown, marked with distinct blackish spots distributed as follows: one immediately behind nape, one before dorsal fin, one at base of adipose fin, — these all on median line; a humeral spot; a very small spot at base of caudal.

It seems highly probable that *D. naufragus* Waite (Waite, Records Australian Museum, 1904, **5**, p. 154, pl. 18, fig. 3), should be placed in the synonomy of this species, the differences indicated by the author being drawn from the somewhat inaccurate drawing of the immature type of *D. asper*.

Rhinoscopelus tenuiculus (Garman).

Myctophum tenuiculum Garman, Mem. Mus. Comp. Zoöl., 1899, **24**, p. 262, pl. J, fig. 5.

A single specimen, 50 mm. long, was taken September 4, 1896, in Lat. N. 10° 57′ 35″. Long. W. 137° 35′ 25″. The species is considered by Brauer (Zool. Anz., 1904, **28**, p. 390) to be a synonym of *R. coccoi*, but comparison

with specimens of the latter from the Atlantic Coast of the United States off Cape Hatteras shows that the two are distinct. *R. tenuiculus* has a much larger head, with deeper, blunter, scarcely protruding snout, and much larger eye. The mouth is smaller compared with length of head. The upper profile is much more curved than the lower, the two nearly equally curved in *coccoi*. In the single specimen before us, the ventral fins contain but seven rays, as in Garman's type, while in all specimens of *R. coccoi* which we have examined there were eight ventral rays; no outer rudimentary ventral ray could be detected in either form. Scales along dorsal and ventral outlines produced and narrowed backward, terminating in an acute point which is more pronounced in *R. tenuiculus* than in *R. coccoi*.

For purposes of comparison, there is given below a table of comparative measurements of *R. tenuiculus* and *R. coccoi* in hundredths of total length without caudal.

	Tenuiculus	Coccoi
Length of head (in hundredths)	26	23
Diameter of eye	8	6
Axial length of snout	4	6
Interorbital width	8	7.5
Length of maxillary	17	16
Greatest depth of head	21	18
Depth at origin of dorsal fin	22	21
Snout to front of dorsal	43	43
Snout to base of ventrals	33	34
Snout to origin of anal	50	53
Snout to adipose fin	73	71
Length to base of caudal	43 mm.	42 mm.
Number of dorsal rays	11	11
Number of anal rays	18	20
Number of ventral rays	7	8
Number of pectoral rays	14	13
Scales in lateral line	38 or 39	41 or 42

Centrobranchus choerocephalus Fowler.

Proc. Ac. Nat. Sci., Phila., 1903, **55**, p. 754; Gilbert, Bull. U. S. Fish Com., 1905, **23**, p. 594, pl. 69, fig. 1.

One small specimen, from Lat. S. 16° 39′, Long. W. 149° 11′, extends the range from the Hawaiian Islands to a point well south of the Equator. No differences are apparent between this and northern specimens. The anals number 6 + 11 on one side, 5 + 10 on the other.

Diaphus nanus, sp. nov.

Plate 1.

Type 17 mm. long, from Hydrographic Station 3798 (A. A. 27), near Nukuhiva Island, Marquesas Group; taken in open intermediate net from surface to 300 fathoms.

Most nearly related to *D. theta* Eigenmann and Eigenmann, from the coast of California, agreeing with this species in its short, bluntly rounded snout, its pair of small circular preocular organs, which are directed forwards, but little visible laterally, and are closely approximated on the median line of the snout; the subocular organ is also short and narrow, often with a minute detached point posteriorly. The species differs from *D. theta* among other respects in the more slender form, the more elevated first antero-anal, the angulated supra-anals, and the closer approximation to the lateral line of the upper supra-anal, the postero-lateral, and the fourth precaudal. *Diaphus fulgens* Brauer apparently has the preocular not circular in shape, widely visible laterally, and the upper series of photophores more distant from the lateral line.

Measurements in hundredths of total length to base of caudal: length of head 31; depth of head at occiput 21; axial length of snout 4; diameter of eye 12; length of maxillary 19; greatest depth of body 23; least depth of caudal peduncle 11; distance from snout to origin of dorsal 48; to insertion of ventrals 46; to origin of anal 61; longest gill-raker 5.

D. 13; A. 13; P. 12; V. 9; lateral line 36; gill-rakers 5 + 13, including all rudiments, Br. 9.

Snout very short, comparatively wide, bluntly rounded; maxillary nearly horizontal, extending beyond orbit a distance nearly equaling half diameter of orbit, its posterior portion not widened; preopercular margin nearly vertical.

Pectorals slender, of 12 rays, broken in all our specimens, but probably not reaching the ventrals; ventrals inserted slightly behind origin of dorsal, reaching vertical from front of anal; origin of dorsal slightly in advance of middle of body; origin of anal just behind last dorsal ray, the adipose dorsal over last anal rays.

Scales all fallen, but those of lateral line apparently not enlarged.

Preocular photophore small, circular, scarcely equaling half diameter of pupil, occupying a pit immediately above nostrils, the two organs narrowly separated mesially by the ethmoidal ridge. They are placed on the anterior aspect of the snout, directed forwards, scarcely visible from the side. Subocular organ short and narrow, below the anterior half of the pupil or a little farther forwards, a minute detached point behind it often to be made out with difficulty. Supra-pectoral spot below opercular angle, its distance from pectoral base scarcely more than half its distance from lateral line; a very narrow white luminous body below it, often scarcely visible. Upper infra-pectoral at base of lower pectoral rays, in a straight line with lower infra-pectoral and first thoracic. Second thoracics only slightly nearer first than fifth pairs, the second and third pairs closely approximated, the elevated fourth pair a little higher on sides than the middle pectoral rays, vertically over interspace between third and fourth thoracics. Supra-ventrals half way between lateral line and the base of ventrals. Ventral organs typically arranged, the first three equally spaced, in an oblique line, the fourth and fifth near median ventral line. Supra-anals forming an angulated line, the upper one on lower margin of the eighteenth scale of lateral line, the middle one half way between the upper and the vent, the lower one in advance of and slightly below the middle spot, the interspace between the two upper spots nearly twice that between the two lower; lower supra-anal very near the fifth ventral, a little above the line connecting fifth ventral and the middle supra-anal. Antero-anals 5, in a wide curve, the first distinctly elevated, forming with the second a very oblique line passing above the

middle supra-anal; second antero-anal nearest the anal base, the third, fourth, and fifth forming a gently diverging curved line which passes behind the postero-lateral. Postero-lateral on the twenty-fourth scale of the lateral line near the lateral line but not in contact with it, its distance from fifth antero-anal nearly twice that separating fifth from fourth. Postero-anals 5 (or 6) in number. Precaudals in a wide shallow curve, nearly evenly spaced, the fourth distinctly below the lateral line.

Color apparently deep brown, lighter on cheeks, mandibles, and snout; black on opercles.

Two co-types from Hydrographic Station 3797 (A. A. 25), and two from 3798 (A. A. 27), near the Marquesas Islands. All are smaller than the type.

Diaphus agassizii, sp. nov.

Plate 2.

Type 21 mm. long, from Hydrographic Station 3798 (A. A. 27), near Nukahiva Island, Marquesas Group; taken with open intermediate net down to 300 fathoms.

Characterized by the deep compressed head and snout, by the absence of preocular or subocular luminous areas, and by the normal number and arrangement of photophores. In *Diaphus urolampus*, the only other species of the genus described without preocular luminous area, there are but two supra-anals, and the second and third ventrals are equally elevated.

Total length, excluding caudal, 18 mm.; length of head, 32 hundredths of this length; diameter of eye 7; length of snout 6; length of maxillary 23; greatest depth of body 23; least depth of caudal peduncle 9; distance from snout to front of dorsal 45; to front of ventrals 42; to front of anal 60; to adipose fin 78.

D. 14; A. 16; P. 13; scales in lateral line 36 to 38; gill-rakers 8 + 13.

Head unusually deep and compressed; eye small, but little above middle of head, barely longer than snout; maxillary not widened posteriorly, its middle point a trifle behind vertical from center of eye; preopercular margin comparatively little oblique.

Pectorals mutilated but evidently weak, probably not reaching the

ventrals; ventrals overlapping front of anal, their insertion under the first rays of the dorsal; origin of anal under last dorsal rays; front of adipose fin vertically above last anal ray.

Scales and much of the epidermis lost, but the ground color evidently dark brown or blackish. An evident pigment line dividing the photophores. A minute round photophore, smaller than any of the others, on the anterior upper margin of the orbit immediately above the nostril, under the anterior projecting rim of the supraorbital portion of the frontal. A similar minute photophore is frequently present in this exact location in many species of *Diaphus* and *Myctophum*, and is frequently to be recognized as distinct from the large preocular luminous area, where this is present in *Diaphus*. In *D. urolampus*, this minute photophore is represented by a densely pigmented black globular body, apparently no longer functional.

Supra-pectoral photophore slightly nearer lateral line than base of pectoral, without the glandular body usually associated with it in this genus; the two infra-pectorals forming with the first thoracic a straight, obliquely ascending line, the spots evenly spaced; first pair of thoracics separated from second pair by a wide interval, about twice the length of the space separating the second pair from the third and the third from the fifth; fourth pair elevated as usual, above and slightly behind the third pair; first three ventrals forming an obliquely ascending line, the second more widely separated from the third than from the first; distance between upper and middle supra-anals more than twice that between the middle and lower; lower supra-anal very near the fifth ventral and a little behind it; antero-anals 7 or 8 in number, the first above and slightly in front of the second, the line joining the two traversing the lateral line slightly behind the upper supra-anal; last antero-anal also elevated, above and behind the next to the last, the line joining the two passing behind the postero-lateral; all antero-anals, except the first and last, in a straight line parallel with the base of the anal fin; postero-anals 4 or 5 in number; precaudals 4, equally spaced, following the curve of the base of the fin; upper supra-anal and the postero-lateral immediately below the lateral line, the upper precaudal somewhat more distant from it, the supra-ventral very slightly nearer lateral line than base of ventrals.

Two small specimens secured at Hydrographic Station 3798 (A. A. 27).

Diaphus signatus, sp. nov.

Plate 3.

Type 60 mm. long, from the surface at Hydrographic Station 3798 (A. A. 27), near Nukuhiva Island, Marquesas Group.

Most nearly related to *Diaphus* (*Nyctophus*) *splendidus* Brauer (Zoöl. Anz., 1904, **28**, p. 399, fig. 7), differing in the smaller head and shorter snout, the less elevated interorbital region which scarcely protrudes above the orbital rim, and the more anterior insertion of the ventral fins. The preocular luminous organ is apparently not divided into upper and lower portions, but has immediately above it a distinct luminous dot surrounded by the black pigment. In general proportions, fin rays, and number and distribution of photophores, this species does not differ from *D. splendidus*.

Length of head 28 hundredths of total length without caudal; diameter of eye 7; length of snout 4.3; length of maxillary 20; greatest depth of body 18; least depth of caudal peduncle 8; distance from snout to front of dorsal, 45; to insertion of ventrals 41; to front of anal 64; to adipose fin 80.

D. 15; A. 15; P. 12; V. 9; lateral line 38; the 11th scale over the supra-ventral photophore, the 18th scale over the upper supra-anal, the 25th over the postero-lateral.

Form slender; snout short and bluntly rounded, its length little more than half the diameter of orbit; maxillary long and slender, not widened posteriorly, its middle well behind the pupil; preopercular margin very oblique; gill-rakers slender, 6 + 13 in number on outer arch, the longest three-fourths the diameter of the eye.

Pectorals small, inserted low, but little above the level of the ventrals, which they fail to reach. Ventrals inserted well in advance of the dorsal, unusually well developed, their longer inner rays extending to base of third or fourth anal ray. The vertical from the last dorsal ray falls between the vent and the front of the anal. Last anal ray under the middle of the adipose fin.

Scales and much of the integument lost, but the general color was

evidently blackish, the bases of the vertical fins black. Dorsal, anal, and caudal fins with the articulations of the rays finely dotted with black, the fins thus with fine wavy cross-lines, which are especially noticeable on the caudal. Two broad dark bars cross the mandibles, one below the posterior part of eye, the other immediately in front of mandibular joint.

Preocular luminous organ occupying the space between the eye and the nostril, extending but little above or below the latter, not extending on the suborbital region. Its anterior margin is deeply indented opposite the nostril, but there is no evident division into an upper and a lower portion. At its upper margin, but separated from it, is a minute round photopore surrounded with pigment, as in *D. agassizii*. No subocular spot, the anterior half of suborbital region bright silvery. Supra-pectoral slightly nearer the lateral line than the pectoral fin, there being associated with it a whitish glandular organ, as in nearly all species of this genus. Lower infra-pectoral spot midway between upper infra-pectoral and first thoracic. First and second thoracics widely separated, the third midway between second and fifth; fourth thoracic elevated as usual in the genus, a little higher than the base of the ventral fins, and slightly behind the third thoracic. Second and third ventral photophores progressively elevated, as usual, the third slightly in front of the vertical from the fourth and below the direct line joining the first and second; the second is much nearer the first than the third. First antero-anal elevated, slightly in advance of the second, which is widely separated from the third; third to sixth antero-anals equally spaced and less widely separated, the third, fourth, and fifth almost equally distant from base of anal, the sixth distinctly elevated, but less so than the first. Postero-anals four in number (five in *splendidus*), the last separated by a wide interval from the first precaudal, which is inserted distinctly in advance of the rudimentary caudal rays. Distance from supra-ventral spot to lateral line two-thirds its distance from ventral fins. The upper supra-anal, the postero-lateral, and the upper precaudal encroach on the scales of the lateral line. Supra-anals slightly angulated, the lower two forming with the fifth ventral an obliquely ascending straight line, which intersect the lateral line behind the upper supra-anal.

In addition to the type, there is a co-type, of equal size, from the same locality.

Dr. Brauer has kindly re-examined the types of *D. splendidus* at the request of the writer and states that the ventral is always inserted under the beginning of the dorsal, the supraorbital region projects always above the eye as shown in the figure, and the snout, although somewhat variable in length, is always more than half the diameter of the eye. In three specimens in which the snout is 1.5 cm., 1.75 cm. and 2 cm. long, the diameter of the eye is 2.1 cm., 2.2 cm. and 2.5 cm. in length.

Lampanyctus townsendi (Eigenmann and Eigenmann).

Plate 4.

Myctophum townsendi Eigenmann and Eigenmann. West American Scientist, 1889, p. 125, from Cortez Banks, south of San Diego, California.

A single young specimen, 26 mm. long, from Hydrographic Station, 3797 (A. A. 25), near Ua Huka Island, Marquesas Group, taken with the open intermediate net between the surface and 300 fathoms.

Measurements in hundredths of length without caudal: Length of head 34; diameter of eye 10; length of snout 7; length of maxillary 25; greatest depth of head 26.5; distance from snout to dorsal 49; to ventrals 48; to anal 63; to adipose fin 79; least depth of caudal peduncle 9.

Dorsal 13; anal 13; pectoral 14; lateral line 38; well-developed gill-rakers 1 + 11, in addition to two short rudiments on vertical and three on horizontal limb of arch.

Body slender, snout short but not bluntly rounded, the premaxillaries mesially about on the level of middle of orbit; maxillary oblique, noticeably but not greatly widened at tip, extending beyond eye a distance about equaling half diameter of orbit. Teeth in very narrow bands, mandibular teeth straight, the inner series somewhat longer than the outer; in the premaxillaries, the inner series is more enlarged, the teeth strongly curved. Preopercular margin rounded, little oblique.

Pectorals mutilated; ventrals reaching at least to front of anal, probably

overlapping, their insertion a little in advance of dorsal; origin of anal under last dorsal ray; adipose dorsal immediately behind anal.

Photophores: A minute antorbital photophore between eye and nostril. Pectorals as usual in this section in a nearly straight vertical line, the upper immediately below the lateral line, the middle in front of base of fin immediately above its middle, the lower nearly vertically below the second, not on shoulder girdle, and not concealed by opercular margin; the line which joins the three passing a little in advance of the second pair of thoracics. Thoracics 5, none of them elevated, the first four pairs forming gently diverging lines, the fifth abruptly diverging, in front of outer ventral rays; interval between first and second pairs longest, nearly equaling that separating second from fourth pairs; third interspace shortest, the fourth less than the second. Supra-ventral vertically over axil of ventral fin, midway between base of ventral and lateral line. Ventrals 5, the anterior pair nearer median line than are the inner ventral rays; second and third pairs more widely separated, opposite the outer half of ventral base; fourth pair nearer median line, fifth pair again diverging. Supra-anals distinctly but slightly angulated, the third pair on lateral line, vertically above first anal ray, the second above or slightly behind the vent, the first farther forward, in a line joining the second supra-anal and the fourth ventral; space between first and second supra-anals about half that between second and third. Antero-anals 7, the first nearest the anal base, the second, third, and fourth in a slightly diverging line, the fifth, sixth, and seventh in a more strongly diverging curve which includes the postero-lateral; the seventh more widely spaced than the preceding photophores, but distinctly nearer the sixth than the postero-lateral. Postero-lateral on the lateral line, under middle of adipose fin, a little behind last anal ray. Postero-anals 5, widely separated from the precaudals, the fifth postero-anal equidistant between second postero-anal and first precaudal. On one side there are apparently two scars of photophores between the post-anal series and the first precaudal, indicating that the two series are continuous. But these cannot be found in other specimens of *townsendi*, nor on the other side of the specimen in question. They may be scars of the minuter photophores which are generally distributed. Precaudals 4, the first three equally spaced, in a gentle curve, the first

opposite first caudal ray; the fourth on the lateral line, well behind and above the third, and separated from it by a wide interval. Luminous patch on underside of caudal peduncle involving rudimentary caudal rays and extending forwards to below first postero-anal photophore; that on back of caudal peduncle short, extending but little in advance of the rudimentary caudal rays, which it covers. Integument of body rubbed so that complete distribution of luminous patches cannot be given, but a series is evident along base of anal fin, and another of four or five luminous scales on median line between ventral and anal fins.

General color blackish, the mouth and gill cavities, including gills and gill-arches and gill-rakers, jet black.

The Ceratoscopelus section of Lampanyctus, to which this species belongs, contains also *L. maderensis* and *L. warmingi*, and is characterized as follows: (1) thoracic and ventral photophores each five in number, none of them elevated; (2) middle pectoral photophore in front of base of pectoral fin; (3) antero-anals forming an ∼-shaped curve, the first are nearest the anal base, the last one or two elevated, forming a curve which includes the single postero-lateral; (4) precaudals 4 in number, sharply distinguished from postero-anals; (5) dorsal and anal short, about equal in length; (6) luminous patches following a definite arrangement which is similar in all the species.

Most nearly related to *L. warmingi* Lütken from the Atlantic, the latter having apparently a much blunter, more rounded snout, but the description inadequate for detailed comparison.

Lampanyctus omostigma, sp. nov.

Plate 5.

Type 62 mm. long, from the surface at 10° 57′ 35″ N. Lat., 137° 35′ 25″ W. Long., in the open Pacific about 1000 miles north of the Marquesas Islands.

Very closely allied to *L. macropterus* Brauer (Zoöl. Anz., 1904, **28**, pp. 397, 401, fig. 5, p. 381), from the Indian Ocean, apparently differing in the following respects:

1. The first anal ray is vertically below the next to the last dorsal ray instead of the middle of the dorsal fin;

2. The supra-pectoral, supra-ventral, and the fourth thoracic photophores are less elevated;

3. The middle pectoral photophore is opposite the upper instead of the middle pectoral rays;

4. The second ventral photophore is in advance of the first instead of behind it;

5. The upper and middle supra-anals are more anteriorly placed and the lower one is more depressed;

6. Interspaces between antero-anals (excepting between first and second pairs) not noticeably greater than between postero-anals.

Measurements in hundredths of total length without caudal: length of head 32; diameter of eye 7.5; axial length of snout 4; length of maxillary 21; greatest depth of body 21; least depth of caudal peduncle 10; distance from snout to front of dorsal 47; length of base of dorsal 16; distance from snout to adipose dorsal 79; to insertion of ventrals 44; to front of anal 60; length of base of anal 21; length of longest gill-raker 5.

Dorsal 14; anal 18; pectoral 13; ventral 9; lateral line 39; gill-rakers 5 + 12. Snout short but not rounded, the upper profile not descending more steeply in front; the snout much shorter than in *L. macropterus*; little more than half diameter of orbit. Maxillary little widened posteriorly, nearly reaching margin of preopercle, extending beyond the eye a distance about equaling the diameter of the latter.

Fins somewhat mutilated, both pectorals and ventrals evidently extending beyond origin of anal; origin of ventrals in advance of dorsal; anal originating under the next to last ray of dorsal, the adipose fin over the last two anal rays. In *L. macropterus*, the origin of the anal is under the middle of the dorsal fin, a character which Dr. Brauer has kindly verified for me on the types of *L. macropterus*.

A minute preorbital photophore surrounded with much black pigment between the eye and the lower portion of nostril. Humeral photophore present, as in *L. macropterus*. Supra-pectoral almost in a direct line joining the lower two pectorals, its distance from lateral line two-thirds its distance

from pectoral; middle pectoral photophore opposite the upper, not the middle, pectoral rays, its distance from lower pectoral spot two-thirds its distance from the upper; line joining middle and lower pectoral photophores passing well in advance of the second thoracic pair. Fourth thoracic greatly elevated, slightly below the middle pectoral (not above as in *L. macropterus*), over anterior part of interspace between third and fifth pairs; other thoracics nearly equidistant from the median line, the posterior slightly diverging; the interval between second and third pairs is the narrowest, that between third and fifth pairs one third the distance between first and fifth, a little shorter than that between first and second. Supra-ventral vertically above ventral axil, its distance from lateral line two-fifths its distance from base of ventrals. First ventrals closely approximated at base of inner ventral rays; second ventrals elevated, about on the level of the lower pectoral photophore and slightly anterior to the vertical from the first ventrals (not well posterior to this vertical as in *L. macropterus*); third ventrals slightly elevated, nearly equidistant between first and fourth pairs; fourth pair closely approximated, at the sides of the vent and a little anterior to it. Supra-anals angulated, the upper in contact with the lateral line, vertically above the first anal ray; middle supra-anal slightly anterior to the upper, in a vertical which passes between vent and first anal ray; lower supra-anal nearly equidistant between middle supra-anal and third ventral, the angle between the three much less than in *L. macropterus*, a line joining the two lower supra-anals traversing the base of the ventral fins. Antero-anals 6, the first and fifth closely approximating anal base and equally distant from it, the first above the fifth anal ray, the fifth above the twelfth; second antero-anals widely diverging; the third and fourth intermediate in position between second and fifth pairs; sixth pair (designated by Brauer as one of the postero-laterals) abruptly elevated, nearer the fifth pair than the postero-lateral, which is in contact with lateral line. Postero-anals 8 or 9, evenly spaced, the second spot immediately above base of last anal ray, the series continuous with the two lower precaudals, which are in no way distinguished from them. Precaudals 4, consisting of the two mentioned, a fourth on the lateral line and a third below and in front of the fourth,

nearly midway between latter and second precaudal. We do not follow Brauer in counting the two anterior precaudals with the postero-anals in cases like the present in which no gap separates the two series. According to Brauer, such an interval may or may not occur in different individuals of *L. macropterus*. In both specimens, the luminous scales are four in number on back of caudal peduncle and nine below, the most anterior of the lower luminous scales being under the interspace between second and third postero-anals (not under fifth postero-anal as in *L. macropterus*).

The general color was evidently dark, blackish on opercles and at bases of fins. Vertical fins with fine wavy lines, due to pigment along the lines of articulation of the rays.

A second specimen, here designated as co-type, of equal length and from the same locality.

Lampanyctus stilbius, sp. nov.

Plate 6.

Type 20 mm. long from Hydrographic Station 3798 (A. A. 27), near Nukuhiva Island, Marquesas Group, taken in open intermediate net between the surface and a depth of 300 fathoms.

Near *L. guentheri*, differing in the presence of photophores on the cheeks and in having numerous minute scattered photophores on head and body, in having 4 instead of 5 ventral photophores, and in a number of details in arrangement of thoracic, ventral, anal, and supra-anal photophores; the eye is also larger. It is still more closely allied to *L. longipes* Brauer (Die Tiefseefische, 1906, p. 236, text-fig. 155), but has the preocular on the ventral instead of the dorsal side of the nostril.

Measurements in hundredths of total length without caudal: length of head 36; diameter of eye 13; axial length of snout 6; length of maxillary 23; greatest depth of body 22; depth of caudal peduncle 9; distance from snout to dorsal 51; to ventral 52; to anal 58.

Dorsal 11; anal 13; pectoral 15; lateral line about 38. Snout short but not bluntly rounded; eye very large, more than one-third length of head; maxillary moderately widened posteriorly, extending beyond eye a distance not much exceeding half its diameter; body slender.

A small but distinct antorbital photophore between the orbit and the lower edge of nostril. Three small photophores on the cheek near the posterior border of the orbit, and apparently a fourth immediately above the maxillary near its end. Apparently a small humeral spot present above anterior part of opercle. Upper pectoral spot on the lateral line, the second in front of pectoral fin just above the middle of the base, the third below and a little behind the second, the three about in a straight line. Thoracics 5, the fourth pair elevated, vertically over middle of interspace between third and fifth pairs; photophores of first pair separated from second pair by an interspace longer than distance from second to fifth pairs; third pair about equidistant from second and fifth pairs; photophores of first pair very close together, those of second pair but little farther apart, those of third pair widely distant (three times the width separating first pair), photophores of fifth pair apparently larger than the others, nearer together than those of third pair, farther apart than those of second pair. This condition is very different from that in *L. guentheri*, where the first, second, third, and fifth pairs form two regularly diverging lines. Supra-ventrals on the lateral line. Ventral photophores 4, the anterior pair opposite middle ventral rays and a little removed from them; second pair elevated, above and behind the first pair, a little lower than fourth thoracics; third pair but slightly nearer fourth than first pair, the photophores of third pair a little farther apart than those of fourth pair, the latter at sides of vent. Supra-anals slightly angulated, the upper distinctly above lateral line, vertically above second anal ray, the second above the first anal ray, the third above the fourth ventral pair; second supra-anal a trifle nearer the lower than the upper one of the series; line joining middle and lower supra-anals passing through the third ventrals. Antero-anals 7, forming a slight ∽-shaped curve, the first a little nearer anal base than the following, the sixth slightly diverging, the seventh more so, the interspaces equal or nearly so; the curve of the last antero-anals crossing lateral line well behind the postero-lateral. Postero-lateral above the lateral line. Postero-anals 4, the last well separated from first precaudal. Precaudals 3 or 4, the two lower well-developed, horizontally placed, approximated at base of rudimentary rays of caudal, the upper above lateral line, the third intermediate in position, sometimes faint or absent.

Minute scattered photophores on head and body, but the integument largely rubbed off, so these are now visible infrequently and are not represented in the drawing. Luminous scales can be made out only on upper and lower sides of caudal peduncle, but such were probably present at base of ventrals and of anterior dorsal and anal rays.

Short luminous patches on upper and lower margins of caudal peduncle, not extending more than one-third distance from caudal rays to anal and adipose fins.

Paired fins broken, their length uncertain; ventrals inserted a trifle behind origin of dorsal; anal originating slightly behind last dorsal ray; adipose dorsal over last anal rays.

A single small specimen in poor condition.

Vinciguerria lucetia (Garman).

Maurolicus lucetius Garman, Mem. Mus. Comp. Zoöl., 1899, **24**, p. 212, pl. J, fig. 2.

Several small specimens, in poor condition, from Hydrographic Station 3798 (A. A. 27), near the Marquesas Islands. It is not clear in what respects this species differs from typical *V. attenuata* (Cocco) from the Atlantic, as characterized by Lütken and Bellotti (see Lütken, Spolia Atlantica, Scopelini, 1892, pp. 270–2). In its slender habit, posterior anus, and the limitation of silvery pigment to the preanal region, as also in the somewhat smaller number of photophores, it agrees with *attenuata*. On the other hand, *Zalarges nimbarius* Jordan and Williams (Proc. Cal. Ac. Sci., 1895, ser. 2, **5**, p. 793, pl. 76), a true *Vinciguerria*, agrees with *V. poweriae* (Cocco) from the Atlantic in its deeper form, anterior position of anus, the extension of the silvery pigment to near the base of the caudal fin and the increased number of photophores. Lütken was unable to distinguish *attenuata* and *poweriae* on the examination of a large amount of material. If his conclusion is valid, it may well prove that *lucetia* and *nimbaria* are the Pacific representatives of a variable and widespread species for which the name *attenuata* must be used. The dorsal fin contains 14 rays in the types of *Z. nimbarius*, not 9 as given.

EXPLANATION OF THE PLATES.

PLATE 1.

Diaphus nanus Gilbert.

Hydrographic Station 3798 (A. A. 27), near Nukuhiva, Marquesas Islands.

PLATE 2.

Diaphus agassizii Gilbert.

Hydrographic Station 3798 (A. A. 27), near Nukuhiva, Marquesas Islands.

PLATE 3.

Diaphus signatus Gilbert.

Hydrographic Station 3798 (A. A. 27), near Nukuhiva, Marquesas Islands.

PLATE 4.

Lampanyctus townsendi (Eigenmann and Eigenmann)

Hydrographic Station 3797 (A. A. 25), near Ua Huka, Marquesas Islands.

PLATE 5.

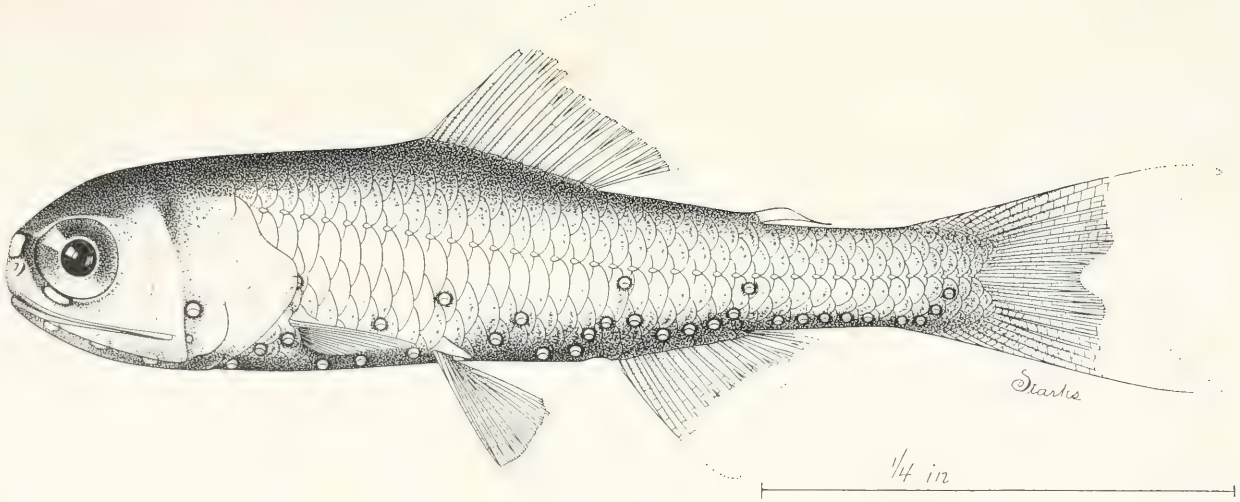
Lampanyctus omostigma Gilbert.

Pacific Ocean, 10° 57′ 35″ N. Lat., 137° 35′ 25″ W. Long., about 1,000 miles north of the Marquesas Islands.

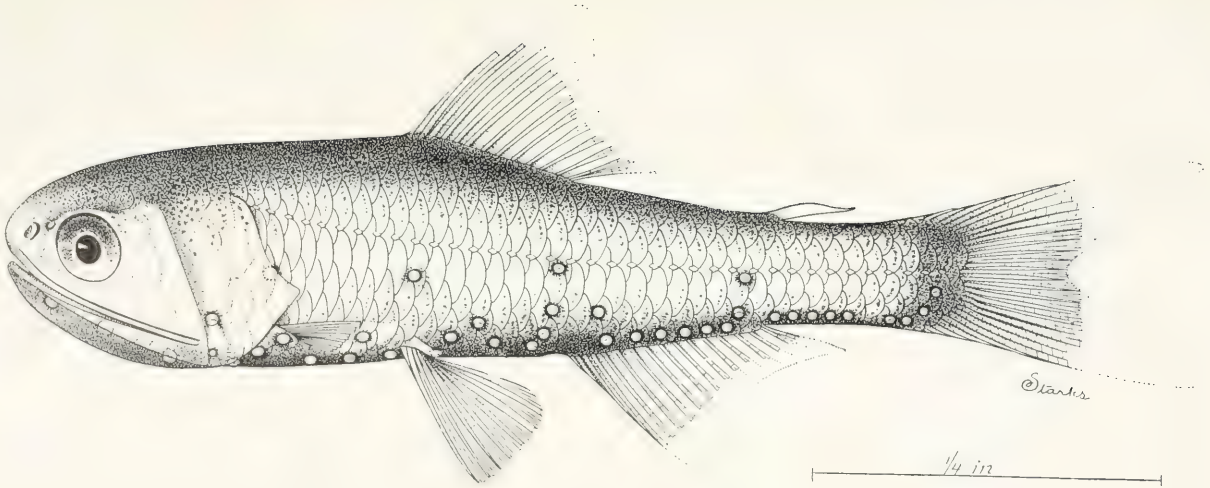
PLATE 6.

Lampanyctus stilbius Gilbert.

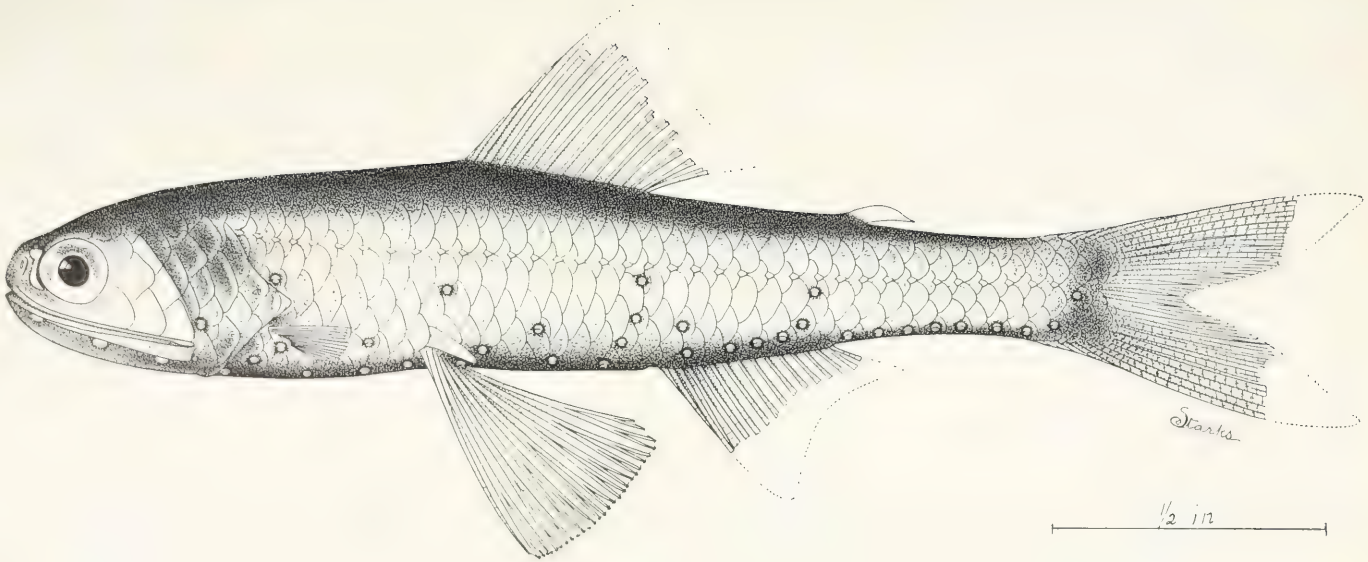
Hydrographic Station 3798 (A. A. 27), near Nukuhiva, Marquesas Islands.



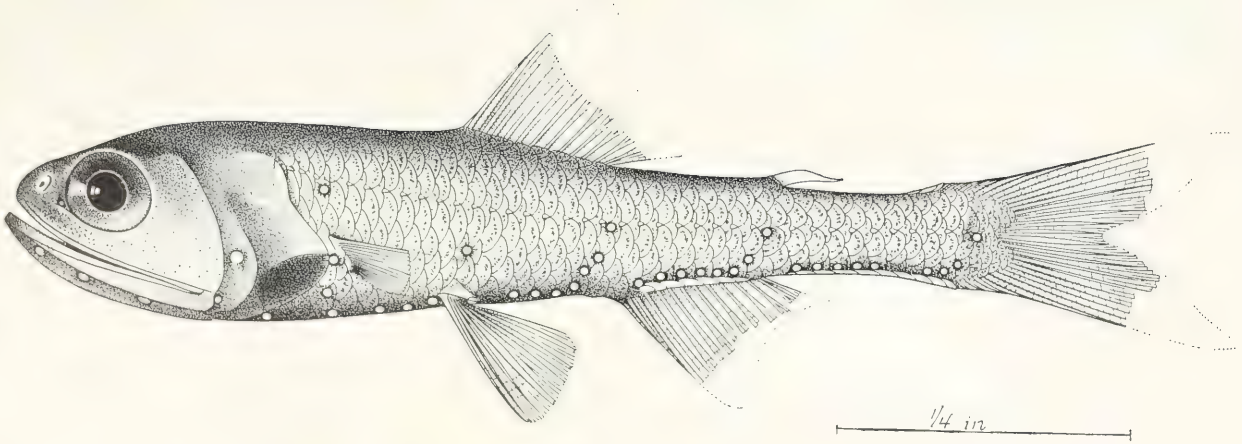
DIAPHUS NANUS GILBERT.



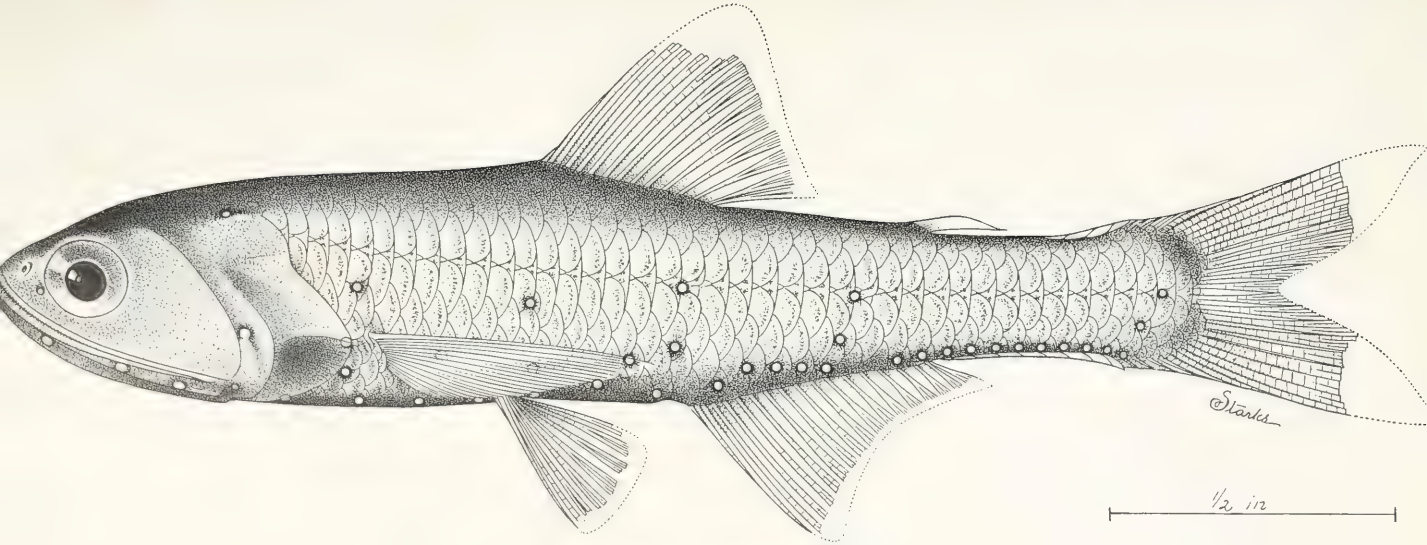
DIAPHUS AGASSIZII GILBERT.



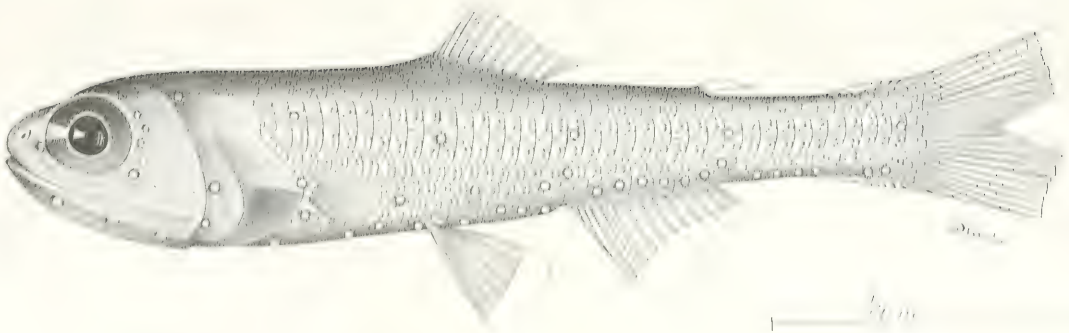
DIAPHUS SIGNATUS GILBERT.



LAMPANYCTUS TOWNSENDI (EIGENMANN & EIGENMANN).



LAMPANYCTUS OMOSTIGMA GILBERT.



Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXVI. No. 7.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, to MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

XIII.

THE SHORE FISHES.

By WILLIAM C. KENDALL and EDMUND L. GOLDSBOROUGH.

WITH SEVEN PLATES.

[Published by permission of George M. Bowers, U. S. Commissioner of Fish and Fisheries.]

CAMBRIDGE, U. S. A.:
Printed for the Museum.
February, 1911.

In the present paper fifty-three families and two hundred and thirty-one species are represented, of which eight species and one genus, Paragobioides, are new.

The new species are *Kuhlia proxima*, *Lutianus marginatoides*, *Therapon maculatus*, *Dascyllus pomacentroides*, *Rupiellia lacunicola*, *Paragobioides grandoculis*, *Petroscirtes quadrimaculatus*, and *Canthigaster constellatus*.

The table (p. 338–343) shows the distribution of the species among the groups as indicated by the collection.

The Friendly Islands, owing to their proximity to the Tonga Group, have been included with the latter.

The plates were made from drawings by Miss Violet Dandridge.

Specimens representing 143 species contained in this collection have been sent to the Museum of Comparative Zoölogy, others including the types of the new species to the U. S. National Museum.

ANNOTATED LIST OF THE SPECIES.

CARCHARIDAE.

Carcharias melanopterus Quoy & Gaimard.

Voy. Uranie. Zool., 1824, p. 194, pl. 43, fig. 1, 2. Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 38, pl. 1.

No. A50, skin of a specimen 36 inches long from Fakarava, Paumotu Islands.

ALBULIDAE.

Albula vulpes (Linné).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 55, fig. 9.
Esox vulpes Linné, Syst. Nat. ed. 10, 1758, p. 313.
Albula glossodon Günther, Fische der Südsee, 1909, **8**, p 385.

Three specimens, No. 08836, $2\frac{3}{4}$ to 3 inches long from Funafuti, Ellice Islands. M. C. Z. 29467 (1 specimen).

CHANIDAE.

Chanos chanos (Forskål).

Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 56, fig. 10. Günther, Fische der Südsee, 1909, **8**, p. 387.

Mugil chanos Forskål, Descript. Anim., 1775, p. 74.

The collection contains the following specimens from the Paumotu Islands, Nos. 05833, 05834, and 05835, M. C. Z. 29772, each 7 inches long, from Makemo, and 05831, M. C. Z. 29771, and 05832, each 7 inches long, from Niau.

CLUPEIDAE.

Stolephorus delicatulus (Bennett).

Clupea delicatula Bennett, Proc. Comm. Zool. Soc. Lond., 1831, p. 168.

Spratelloides delicatulus Bleeker, Atlas Ichth., 1866–72, **6**, p. 89, 96, tab. 264, Clup., 6, fig. 3.

No. 09023, fifteen specimens $\frac{7}{8}$ to $2\frac{3}{16}$ inches long, and three specimens, No. 09028, M. C. Z. 29520, $1\frac{5}{8}$ to $1\frac{3}{4}$ inches long, all from Taritari, Gilbert Islands; No. 09062, forty-nine specimens $1\frac{3}{16}$ to $1\frac{13}{16}$ inches long from Arhno, Marshall Islands, and two specimens, No. 09007, small and mutilated, from Rangiroa, Paumotu Islands.

Harengula kunzei Bleeker.

Nat. Tijds. Ned. Ind., 1856, **12**, p. 209.

Clupea (Harengula) kunzei Bleeker, Atlas Ichth., 1866–72, **6**, p. 89, 91, 100, 107, tab. 263, Clup. tab. 5, fig. 1.

Clupea kunzii Günther, Fische der Südsee, 1909, **8**, p. 382.

Two specimens, No. 08931 and 09000, $2\frac{3}{4}$ and $4\frac{1}{4}$ inches long from Jaluit, Marshall Islands, and eighty-six specimens, Nos. 05791–92, M. C. Z. 29459 (14 specimens) and 09006 (young) $1\frac{1}{4}$ to 2 inches long, all from Suva, Fiji Islands.

Harengula sundaica Bleeker.

Clupea (Harengula) sundaica Bleeker, Atlas Ichth., 1866–72, **6**, p. 89, 99, 105, tab. 261, Clup. 13, fig. 5.

Thirty-two specimens, No. 05794, $1\frac{1}{2}$ to 3 inches long, from Nukuhiva, Marquesas Islands. M. C. Z. 29507 (7 specimens).

Harengula commersoni (Cuvier & Valenciennes).

Clupeonina commersoni Cuv. & Val., Hist. Nat. Poiss., 1847, **20,** p. 350.
Alausa melanura Cuv. & Val., Hist. Nat. Poiss., 1847, **20,** p. 324.
Clupea (Harangula) melanurus Bleeker, Atlas Ichth., 1866–72, **6,** p. 89, 100, 111.
Clupea (Paralosa) melanurus, tab. 269, Clup. 11, fig. 5.
?Clupea atricauda Günther, Fische der Südsee, 1909, **8,** p. 381.

Two specimens, Nos. 05788–9, M. C. Z. 29386, each $4\frac{1}{2}$ inches long, from Vavau, Tonga Islands. One specimen, No. 05793, $3\frac{4}{5}$ inches, Papeete, Tahiti, Society Islands; six specimens, Nos. 08817–19, 08825, 08887–8, $4\frac{1}{2}$ to $5\frac{1}{5}$ inches long from Suva, Fiji Islands.

SYNODONTIDAE.

Saurida gracilis (Quoy & Gaimard).

Günther, Fische der Südsee, 1909, **8,** p. 376.
Saurus gracilis Quoy & Gaimard, Voy. Uranie. Zool., 1824, p. 224.

One specimen, No. 09005, $6\frac{1}{2}$ inches long, from Makemo, Paumotu Islands. Three specimens, No. 08907, M. C. Z. 29525, $1\frac{1}{4}$–$2\frac{1}{4}$ inches long, Truk Group, Caroline Islands.

ANGUILLIDAE.

Anguilla mauritiana Bennett.

Proc. Comm. Zool. Soc. Lond., 1831, p. 128. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25,** p. 192.

No. A196, M. C. Z. 29737, 27 inches, and No. A197, 32 inches long from Kusaie, Caroline Islands.

Anguilla otaheitensis Kaup.

Neue Aalachnliche Fische des Hamburger Mus., 1859, p. 17, tab. 2, fig. 2.
Anguilla anietensis Günther, Chall. Rept., 1880, p. 58.

We have the following specimens from Papeete, Tahiti, Society Islands:

No. A33, a specimen $17\frac{1}{4}$ inches long. Vomerine teeth extending almost or quite as far back as the maxillary teeth; gape about 3 in head, extending past posterior border of eye; dorsal beginning about an inch in front of vent.

No. A32, a specimen $18\frac{1}{2}$ inches long. Vomerine teeth extending nearly as far back as maxillary teeth; gape about 3 in head and extending past posterior border of eye; dorsal beginning about $\frac{3}{8}$ inch in front of vent.

No. A34, M. C. Z. 29752, a specimen 15 inches long. Vomerine teeth not extending back quite so far as maxillary teeth; gape extending but a little beyond posterior border of eye, about 3 in head; dorsal beginning about $\frac{11}{16}$ inch in front of vent.

A specimen, no tag or locality, $20\frac{3}{4}$ inches long. Vomerine teeth not extending so far back as maxillary; gape about 3 in head extending back considerably farther than eye; dorsal begins $1\frac{5}{16}$ inches in front of vent.

Jordan & Seale (Bull. U. S. Bur. Fish., **25**, p. 192), place *Anguilla aneitensis* Günther (Chall. Rept. p. 58), as a synonym of *A. megastoma*. We cannot see upon what grounds this is done, as all that Günther says about it is that it was a malformed specimen from a river near Lake Waihirra.

Three of our specimens come from the type locality of *A. otaheitensis* and they are undoubtedly that species. There is some variation in the relative position of the origin of the dorsal and the relative extent of the vomerine teeth, which suggests that these characters are not of much specific value. The other specimen shows no tangible differences, and there is a possibility that they all belong to some earlier described species.

MYRIDAE.

Muraenichthys macropterus Bleeker.

Act. Soc. Sci. Indo-Nederl., 1864, **4**, p. 11, Amboina 8, p. 91. Atlas Ichth., 1864, **4**, p. 31, tab. 151, Mur. 7, fig. 3.

Six specimens, No. 09966, $2\frac{1}{8}$ to $4\frac{7}{16}$ inches long from Arhno Atoll, Marshall Islands. M. C. Z. 29500 (2 specimens).

Muraenichthys schultzei Bleeker.

Nat. Tijds. Ned. Ind., 1857, **13**, p. 366. Atlas Ichth., 1864, **4**, p. 31, 33, tab. 148, Mur. 4, fig. 3.

Three specimens, $2\frac{3}{4}$ to 3 inches long from Funafuti, Ellice Islands. M. C. Z. 29594 (1 specimen).

In dental characters our specimens agree with Bleeker's description but the origin of the dorsal, so far as can be discerned, seems to be situated more posteriorly, more like *M. gymnotus*.

OPHICHTHYIDAE.

Leiuranus semicinctus (Lay & Bennett).

Ophisurus semicinctus Lay & Bennett, Zool. Beechey's Voyage, 1839, p. 66, pl. 20, fig. 4.
Leiuranus colubrinus Bleeker, Atlas Ichth., 1864, **4**, p. 42, tab. 163, Mur. 19, fig. 1.

One specimen, No. 09063, 6 inches long from Arhno Atoll, Marshall Islands.

MURAENIDAE.

Gymnothorax richardsonii Bleeker.

Atlas Ichth., 1864, **4**, p. 85, 100, tab. 186, Mur. tab. 42, fig. 2.
Muraena richardsonii Bleeker, Nat. Tijds. Ned. Ind., 1852, **3**, p. 296.

Two specimens, No. 05783, 05784, M. C. Z. 29792 (small), Bora Bora, Society Islands.

Gymnothorax pictus (Ahl).

Muraena picta Ahl, Specimen Ichthyologicum de Muraena et Ophichtho, 1789, p. 8, pl. 2, fig. 2.

The collection contains the following specimens from Paumotu Islands: No. 08822, $14\frac{1}{2}$ inches long from Anaa. No. A52, M. C. Z. 29760 $16\frac{3}{4}$ inches long from Fakarava; No. 05771, $13\frac{1}{2}$ inches long, No. 05770, $13\frac{1}{2}$ inches long, and No. 05772, M. C. Z. 29761, $14\frac{1}{2}$ inches long, from Makemo. No. A36, $20\frac{1}{2}$ inches long from Tikei. No. A20, 23 inches long from Rangiroa. Another specimen, No. A156, 18 inches long from Funafuti, Ellice Islands, and Nos. 09044, 6 inches long and 09043, $9\frac{1}{2}$ inches long from Jaluit, Marshall Islands.

The following notes were taken from the above specimens:

Color of No. 08822, in alcohol, creamy white, thickly speckled with brown on back and sides, belly plain white, specks arranged in irregular, crowded groups, same color on dorsal fin; this grouping on the white background gives a faint reticulated effect, the reticulations being of the pale color; anal white;

dots on the head not extending forward beyond posterior edge of eye, or below upper jaw, though on one side there are two or three dots in front of eye.

Color of Nos. 09043–4, in alcohol, ground color yellowish, probably gray in life; dorsal, back and sides with small irregular brownish rings and broken rings and irregular groups of coalescing spots; spots on lower side of abdomen distinct, not coalescing; belly unspotted, top and side of head with small distinct spots, extending to end of snout, but none on jaws, or under lower jaw.

No. A156, M. C. Z. 29759. This specimen is very thickly speckled with small purplish brown specks, which sometimes coalesce into larger spots; lower jaw and throat with numerous small spots and specks; belly plain.

No. A52. Color similar to A156, but with fewer specks on lower jaw and throat.

No. 05771. Color similar to that of A52.

No. 05770. Color similar to No. 05771, in addition, however, it has a few small spots on belly; spots on throat and lower jaw are a little larger and more scattering.

No. A36. Very thickly spotted with larger spots than the last, amongst which the ground color makes a fine reticulated effect; throat and lower jaw thickly spotted with comparatively large spots.

No. A20. Color cannot be clearly made out, seemed to be finely speckled; lower jaw has scattering small spots, none on throat.

No. 05772. Color badly faded, seemed to have had fewer spots, which were more coalescing into rings and groups; throat not spotted; lower jaw with very few small specks.

Gymnothorax rupelliae (McClelland).

Dalophis rupelliae McClelland, Calcutta Journ. Nat. Hist., 1845, **5**, p. 213.

Gymnothorax reticularis Bleeker, Atlas Ichth., 1864, **4**, p. 85, 98, tab. 177, Mur. 33, fig. 1, and tab. 183, Mur. 39, fig. 2; tab. 181, Mur. 37, fig. 4 (not of Bloch).

One specimen, No. 05786 (small), Rangiroa, Paumotu Islands.

Gymnothorax tessellatus (Richardson).

Bleeker, Atlas Ichth., 1864, **4**, p. 85, 93, tab. 171, Mur. 27, fig. 3.

Muraena tessellatus Richardson, Zool. Voy. Sulphur. Ichth., 1845, p. 109, pl. 55, fig. 5–8.

One specimen, No. 05785, $3\frac{3}{4}$ inches long from Rangiroa, Paumotu Islands.

Gymnothorax stellatus (Lacépède).

Muraenophis stellatus Lacépède, Hist. Nat. Poiss., 1803, **5**, p. 622, 629, 644.

Muraena fimbriata Bennett, Proc. Comm. Zool. Soc. Lond., 1831, p. 168. Day, Fishes of India, 1878, p. 670, pl. 172, fig. 1.

No. 05775, a specimen $7\frac{3}{4}$ inches long, and 05782, M. C. Z. 29580, $3\frac{3}{4}$ inches long, from Fakarava, Paumotu Islands.

Echidna tritor Vaillant & Sauvage.

Rev. et Mag. Zool., 1875, **3**, p. 287.

Echidna leihala Jenkins, Bull. U. S. Fish Comm., 1903, **22**, p. 428, fig. 9. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 203.

No. 05773, a specimen $9\frac{1}{2}$ inches long and 05774, M. C. Z. 29579, $5\frac{1}{2}$ inches long, from Fakarava, Paumotu Islands. In the position of the vent, which is nearer the tip of snout than the tip of tail, these specimens agree with *E. psalion*.

Enchelynassa canina (Quoy & Gaimard).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 197.

Muraena canina Quoy & Gaimard, Voy. Uranie. Zool., 1824, p. 247.

No. A51, $18\frac{1}{2}$ inches long from Fakarava, Paumotu Islands.

Uropterygius pantherinus (Lesson).

Ichthyophis pantherinus Lesson, Voy. Coquille. Zool. Poiss., 1830, **2**, p. 131, Atlas, pl. 13.

Gymnomuraena pantherina Bleeker, Atlas Ichth., 1864, **4**, p. 112, 113, tab. 175, Mur. 31, fig. 3.

Number A49, a specimen $23\frac{1}{2}$ inches long from Fakarava, Paumotus.

Sharp curved teeth in both jaws in several irregular rows that are hard to count; at least four rows anteriorly, bunched in front of vomer and at the junction of upper jaw; vomer with two rows of teeth anteriorly, single row posteriorly, those in front curved backward, the posterior three curved forward. No vestige of fin except at extremity of tail.

This specimen is very certainly identifiable with *Gymnothorax pantherina* in Bleeker's Atlas. Bleeker states that his specimens are quite certainly the same as Lesson's *Ichthyophis pantherinus*, and suggests the possibility of its being the *Gymnomuraena marmorata* Lacépède. It is, however, quite as certain

that our specimens, as well as Bleeker's, are not *Gymnothorax marmorata*, if those recorded from the Hawaiian Islands by Jordan & Evermann, and those from Samoa by Jordan & Seale, are correctly identified.

While Lesson's *Ichthyophis pantherinus* has been included in the synonymy of *Uropterygius marmorata*,[1] it has not the same character of vertical fins on the tail, in fact it has practically none, while *U. marmorata* from Hawaii has the vertical fins extending a short distance on the tail both above and below. There is nothing in Lesson's description to show the number of the rows of teeth or whether the posterior nostril was tubular or not. In fact no posterior nostril is shown in the figure, but the color, shape, and character of the tail, are much like those of our specimens, which have the posterior nostril tubular. We therefore retain Lesson's specific name and place it in Uropterygius.[2]

[1] *Uropterygius marmorata* in Fishes of Hawaiian Islands, Jordan & Evermann, is incorrectly illustrated by a figure of *Callechelys marmorata* copied from tab. 155, Mur. 11, fig. 2 of Bleeker's Atlas. Probably *Gymnomuraena macropterus*, p. 113, 115, and *G. xanthopterus*, p. 112, 114 and tab. 164, Mur. 20, figs. 2 and 4 of Bleeker's Atlas and possibly *G. macrocephalus*, p. 112, and 114, tab. 166, Mur. 21, fig. 2, are correctly included in the synonymy of *U. marmorata*.

[2] In Fishes of Hawaiian Islands Jordan & Evermann place the genus Ichthyophis Lesson in the synonymy of Uropterygius as follows: "Ichthyophis Lesson, Voy. de la Coquille, 1829, **2**, p. 131, (*pantherinus* = *marmoratus*); not of Fitzinger 1829 (1826) a genus of reptiles."

Also in their synonymy of *Uropterygius marmoratus* occurs: — *Ichthyophis pantherinus* Lesson, Voy. Coquille. Zool. Poiss., 1829, **2**, p. 131

In the Proceedings of the U. S. Nat. Mus. 1901, **23**, p. 886, Jordan & Snyder establish the genus Scuticaria, retaining as type of the genus *Ichthyophis tigrinus* Lesson, having the posterior as well as the anterior nostril tubular.

In Fishes of Hawaiian Islands, (Bull. U. S. Fish Comm. 1905, **23**, pt. 1, p. 112) Jordan & Evermann in the synonymy of *Scuticaria* have:— "*Muraenoblenna* Kaup, Cat. Apod. Fish., 97, 1856 (*tigrina*); not of Lacépède, 1803, which is a *Myxine*." In the same work (p. 113) in the synonymy of *Scuticara tigrina*, they include "*Ichthyophis tigrinus* Lesson, Mem. Soc. Hist. Nat. Paris, IV, 399, 1829." Rüppell shows, in the figure of *Uropterygius concolor*, a short tube at posterior nostril, and says in the description of this species:— "Nasenlöcher wie gewohnlich bei den Muraenen mit Kurzen Hautfühlern versehen." This does not necessarily exclude posterior nostrils.

Jordan & Evermann in the description of *U. marmorata*, state that the anterior nostrils are in short tubes and the posterior have elevated rims. A specimen of theirs, from the Hawaiian Islands, shows the posterior tube as long as the anterior. Specimens in the U. S. Nat. Mus. from the same locality and labeled *Uropterygius marmorata*, that are 5 to 6 inches long, show, in the smaller examples, no rim, and in the larger, a very slight rim at posterior nostril.

These resemble specimens of the same size from Samoa, labeled *Uropterygius concolor*, all of which are exactly like specimens in our collection which we have identified as young *U. marmorata*. Larger specimens from Samoa labeled "*Scuticaria marmorata*," show posterior nostril tubes as they are in a specimen of *Scuticaria tigrinus* of the same size from Hawaii.

It thus seems that the presence or absence of posterior nasal tubes affords no basis for separating the genera on this character, and the genus Scuticaria will have to be dropped in favor of Uropterygius.

The type of *Ichthyophis* is *tigrinus* and not *pantherinus* (Lesson, Mem. Soc. Hist. Nat. Paris, 1828, **4**, p. 400).

Uropterygius marmoratus (Lacépède).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 111, fig. 33.
Gymnomuraena marmorata Lacépède, Hist. Nat. Poiss., 1803, **5**, p. 648.

We have the following specimens from Paumotu Islands: —

Nos. A54, 05776, 05777, M. C. Z. 29581, 4 to 9½ inches long from Fakarava, and 05787, two small specimens from Makemo, M. C. Z. 29471.

In No. A54 the color in alcohol is dark olive-green, thickly marbled with darker; fins at the end of the tail not noticeably lighter.

In the smaller (young) examples, in which we can detect no other tangible differences, the color is uniform purplish brown without evident marbling, fins at the tail yellowish white.

U. marmoratus and *concolor* are very probably the same species. In very young individuals we can find no differences except a slight difference in color and these do not show in alcoholic specimens.

Uropterygius concolor Rüppell.

Neue Wirb. Fische, 1835, p. 83, taf. 20, fig. 4.

Two specimens, No. 09009, $1\frac{15}{16}$ and $2\frac{1}{2}$ inches long from Rangiroa, Paumotu Islands. M. C. Z. 29475 (1 specimen).

BELONIDAE.

Belone platyura Bennett.

Proc. Comm. Zool. Soc. London, 1830, p. 168. Günther, Fische der Südsee, 1909, **8**, p. 349.

Three specimens, No. A136, 12 to 14½ inches long from Kambara, Fiji Islands.

The specimen numbered A136 has dorsal I, 14; anal I, 17; eye equals interorbital; another specimen has dorsal I, 13; anal I, 17; eye slightly greater than interorbital width; the other has dorsal I, 13; anal I, 18; eye slightly greater than interorbital width.

Another specimen, No. 08847, M. C. Z. 29774, 13 inches long from Funafuti, has dorsal I, 14; anal I, 18; eye equals interorbital.

HEMIRAMPHIDAE.

Hemiramphus dussumierii Cuvier & Valenciennes.

Hist. Nat. Poiss., 1846, **19**, p. 33 (24), pl. 554. Günther, Fische der Südsee, 1909, **8**, p. 354.

Five specimens, No. A117, $8\frac{1}{2}$ to 10 inches long from Namuka, Tonga Islands, give the following measurements:

Dorsal I, 15; A. I, 14; dorsal and anal scaled, the anal especially so; ventral nearer caudal than head; scales 52?

Dorsal I, 13; A. I, 13; dorsal scaled, the anal slightly so; ventral midway between head and base of caudal, slightly nearer head if anything; scales 52?

Dorsal I, 14; A. I, 13; dorsal and anal scaled; ventral exactly midway between head and base of caudal; scales 55.

Dorsal I, 13; A. I, 13; dorsal and anal scaled; base of ventral slightly nearer caudal than head; scales about 55.

Dorsal I, 14; A. I, 14, no scales on dorsal; anal closely scaled; base of ventral midway between head and caudal, scales about 52; eye equals interorbital, 1.25 in postorbital part of head.

The collection also contains the following specimens:

No. 09034, $3\frac{1}{2}$ inches long from Mille, Marshall Islands. No. 08947, 8 inches long from Kusaie, Caroline Islands. Twenty-one specimens (young) from Fakarava, Paumotu Islands. Seven specimens $8\frac{1}{8}$ to $10\frac{1}{4}$ inches long, and Nos. A121, M. C. Z. 29731, A122, 8 and 11 inches long, from Vavau, Tonga Islands. No. A147, $11\frac{1}{2}$ inches long from Suva, Fiji Islands. One specimen, No. 09013 (young) from Guam. This specimen had dorsal 15; anal 14; scales about 52; ventral midway between caudal and head.

Hemiramphus affinis Günther.

Cat., 1866, **6**, p. 267.

One specimen, No. 09045, M. C. Z. 29503, $4\frac{3}{4}$ inches long from Tarawa, Gilbert Islands. Dorsal I, 15; scales about 60; ventral nearer caudal than head.

One specimen, No. 08958, $9\frac{1}{10}$ inches long, from Kusaie, Caroline Islands.

Two specimens taken in the Caroline Islands, one No. 08958, $9\frac{1}{10}$ inches long at Kusaie, and one No. 09058, 3 inches long at Moen. This last specimen has 16 dorsal rays and 16 anal rays, ventral midway between head and caudal.

Seventeen specimens from Marshall Islands, two of them, No. 08959, $5\frac{7}{16}$ and $5\frac{1}{2}$ inches long from Wotje Atoll; fourteen of them (young) No. 09075 and one small mutilated specimen, No. 09041 from Arhno.

Hemiramphus far (Forskål).

Günther, Fische der Südsee, 1909, **8**, p. 357.
Esox far Forskål, Descript. Anim., 1775, p. 67.

No. A118, a specimen 17 inches long and No. A119, M. C. Z. 29730, 15 inches long from Vavau, Tonga Islands.

Zenarchopterus dispar (Cuvier & Valenciennes).

Günther, Fische der Südsee, 1909, **8**, p. 358.
Hemirhamphus dispar Cuv. & Val., Hist. Nat. Poiss., 1846, **19**, p. 42 (58), pl. 558.
Zanarchopterus vaisiganis Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 208, fig. 11

Two specimens, Nos. 09022, and 08925, M. C. Z. 29366, $6\frac{1}{5}$ and $6\frac{11}{20}$ inches long from Kusaie, Caroline Islands. Fourteen specimens, Nos. 08881 and 08993, $4\frac{3}{4}$ to $6\frac{1}{4}$ inches long, and No. 05943, in very bad condition, all from Suva, Fiji. Two specimens, No. 09094, M. C. Z. 29390 from Guam, very bad condition, unidentifiable with certainty, with longer bill than the others, but this seems to be an age character.

All these specimens have been compared with specimens in the U. S. National Museum, with three specimens of *Z. dispar* from the Philippines, with types and cotypes of *Z. vaisiganis*, with descriptions and figures in Cuvier & Valenciennes, Bleeker, and in Day, and no differences can be detected by which to separate them from *Z. dispar; Z. vaisiganis* seems identical.

EXOCOETIDAE.

Exocoetus volitans Linné.

Syst. Nat. ed. 10, 1758, p. 316. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 133, fig. 45.

No. 05809, $1\frac{9}{16}$ inches long from tow-net, open Pacific, Albatross, Sept. 8, 1899, 8 P. M., in Lat. 4°, 35′ N., Long. 136°, 54′ W.

This is provisionally identified as above, it being too small for positive identification.

Back dark brown, lower parts silvery; dark brown band extending between the posterior half of dorsal and anal and extending somewhat on fins; base of caudal dark brown; pectorals pale with a large very dark brown blotch, occupying upper posterior half of fin, but not extending to the tips of the rays which are pale.

Cypsilurus speculiger (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 209, fig. 13 (poor).

Exocoetus speculiger Cuv. & Val., Hist. Nat. Poiss., 1846, **19**, p. 69 (94). Günther, Fische der Südsee, 1909, **8**, p. 366.

No. A200, M. C. Z. 29765, two specimens 10 and 11 inches long from off Guam.

Cypsilurus bahiensis (Ranzani).

Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 136.

Exocoetus bahiensis Ranzani, Nov. Comm. Ac. Sci. Inst. Bonon., 1842, **5**, p. 326, pl. 38. Günther, Fische der Südsee, 1909, **8**, p. 369.

No. A184, 12 inches long from Arhno, Marshall Islands.

This specimen agrees very well with Day's description (Fishes of India, p. 519) except that, in our specimen, the anal fin is inserted opposite the end of the first third of the dorsal. Day says that it commences below the last third of dorsal fin, but his figure (Plate 121, fig. 10) shows that it commences very slightly in advance of the middle of the dorsal.

ATHERINIDAE.

Atherina lacunosa Forster.

Bloch & Schneider, Syst Ichth., 1801, p. 112. Descript. Anim. Ed. Lichtenstein, 1844, p. 298. Cuvier & Valenciennes, Hist. Nat. Poiss., 1835, **10**, p. 337 (454).

Sixteen specimens, No. 09078, 1 to $2\frac{1}{4}$ inches long from Wotje Atoll, Marshall Islands. Also M. C. Z. 29464, No. 09084, $1\frac{3}{4}$ inches long, from Moen, Truk Group, Caroline Islands.

Dorsal VI to VII — I, 9 to I, 10; anal I, 12 to I, 14; scales about 44 or 45 counting entire longitudinal series. Of six specimens three have 6 dorsal spines

and three have 7; only one has 9 rays, the rest have 10. Of the anal rays, one has 12, four have 13, the others have 14.

Atherina endrachtensis Quoy & Gaimard.

Voy. Uranie. Zool., 1825, p. 334. Günther, Cat., 1861, **3**, p. 401.

Four specimens from Marshall Islands, No. 09035, $1\frac{1}{2}$ inches with dorsal VII–I, 10; anal I, 10 or 11 from Likieb and three specimens, No. 09071, $1\frac{9}{16}$ to $2\frac{1}{8}$ inches long from Ahrno. Origin of dorsal a little nearer ventral than anal.

1. D. VII–I, 9; A. I, 10 or 11; scales 42 counting all the developed scales in longitudinal series.

2. D. VI–I, 9; A. I, 10 or 11; scales 42.

3. D. V–I, 9; A. I, 11; scales 42.

Fourteen specimens from Moen, Truk Group, Caroline Islands, as follows:—

No. 09084 (part) six specimens $1\frac{5}{8}$ to $1\frac{7}{8}$ inches long and No. 08906 (part) eight specimens, M. C. Z. 29394, to $1\frac{3}{4}$ inches long.

No. 08906, had D. VI–I, 9; A. I, 10 or 11 for seven specimens, the other specimen has D. VII–I, 9; A. I, 10 or 11.

Twenty-seven specimens, No. 09055 (poor condition) 1 to $1\frac{5}{16}$ inches long, from Suva, Fiji Islands. Five specimens, $\frac{13}{16}$ to $1\frac{3}{8}$ inches long from Rangiroa, Paumotu Islands.

One specimen, part of No. 09017, $1\frac{5}{8}$ inches long from Guam.

Head $2\frac{2}{3}$ in length; depth $5\frac{4}{5}$; eye about equal interorbital, $2\frac{4}{5}$ in head; snout about $\frac{4}{5}$ of eye; mouth very oblique, maxillary reaching anterior margin of eye; origin of dorsal slightly nearer ventral than anal, about midway between tip of snout and base of caudal.

We have identified this as *A. endrachtensis*, although it differs slightly from current descriptions, most noticeably in length of snout and width of interorbital. It is close to *A. vaigiensis*, but is generally more slender and with a deeper caudal peduncle, proportionally smaller eye, and considerably longer snout.

Atherina vaigiensis Quoy & Gaimard.

Voy. Uranie, Zool., 1825, p. 335.

Fifteen specimens, No. 05820, $3\frac{1}{2}$ to $4\frac{3}{4}$ inches long from Makemo, Paumotu Islands. Six specimens No. 09017, $1\frac{1}{2}$ to 2 inches long from Guam. One hundred and thirty-eight specimens from Moen, Truk Group, Caroline Islands, as follows:—

M. C. Z. 29394, No. 08906, forty-eight specimens $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, M. C. Z. 29488, No. 09084, thirty-one specimens $1\frac{1}{4}$ to $2\frac{1}{2}$ inches, and No. 08983, fifty-nine specimens 1 to $3\frac{3}{4}$ inches long.

Of the 59 specimens twenty examined show dorsal spines to vary from IV to VI, and rays 1, 10 or 11; anal I, 14 to I, 16; there are but two with IV spines in dorsal, seven with V, and eleven with VI. There are five with 10 dorsal rays, the others having 11 rays. There are three with 14 anal rays, sixteen with 15 rays, and one with 16 rays. There seems to be a true spine in front of the anal and a simple ray in front of the dorsal. Scales range from 43–46 but they cannot be counted with certainty, three of them apparently having 43, thirteen 44, two 45, and two 46. The eyes vary somewhat in relation to interorbital, but this is due doubtless to the action of the preservative. In some instances the eye is very little longer than interorbital width, in others somewhat more so, and in others very much more so. Some of these specimens have a slightly longer maxillary than others, and some are somewhat darker than others. These latter differences do not seem to be related to any particular variation shown in the other differences mentioned.

Günther has identified this species, erroneously we believe, with *Atherina lacunosa*. It is very close to, if not identical with, *Atherina forskalii* of Rüppell. It agrees with Day's description and figure of *A. forskalii*.

Atherina uisila Jordan & Seale.

Bull. U. S. Bur. Fish., 1906, **25**, p. 216, fig. 23.

One specimen No. 09046, $3\frac{1}{2}$ inches long from Wotje Atoll, Marshall Islands. Dorsal VI–I, 9; anal I, 12; scales 44 (48).

MUGILIDAE.

Liza caeruleomaculatus (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 217.
Mugil caeruleomaculatus Lacépède, Hist. Nat. Poiss., 1803, **5**, p. 385, 386, 389, 392.

Sixteen specimens from Caroline Islands, No. 09090, fifteen specimens $1\frac{1}{8}$ to $1\frac{3}{4}$ inches long from Moen and one specimen, No. 09020, $6\frac{1}{4}$ inches long from Kusaie. Thirty specimens, No. 05818, $\frac{1}{2}$ to $2\frac{3}{4}$ inches long from Vavau, Tonga Islands. Sixteen specimens, M. C. Z., 27510, $\frac{3}{4}$ to $2\frac{1}{8}$ inches long, from Tongatábu, Tonga Islands. One specimen M. C. Z. 29532, 2 inches long from Suva, Fiji Islands. Three specimens, No. 08981 (part) each $1\frac{1}{2}$ inches long from Guam.

Liza melinoptera (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 217.
Mugil melinoptera Cuv. & Val., Hist. Nat. Poiss., 1836, **11**, p. 108 (146).

Three specimens $1\frac{1}{2}$ to $1\frac{3}{5}$ inches long from Tongatábu, Tonga Islands. M. C. Z. 29418 (1 specimen).

Liza troschelii (Bleeker).

Mugil troschelii Bleeker, Nat. Tijds. Ned. Ind., 1858, **16**, p. 277. Günther, Cat., 1861, **3**, p. 448.

Seventeen specimens, $2\frac{3}{4}$ to $4\frac{1}{2}$ inches long and No. 05813, 4 inches long from Makemo, Paumotu Islands. Thirty specimens, 05814, $1\frac{3}{8}$ to 4 inches long from Bora Bora, Society Islands. One specimen, No. 09095, M. C. Z. 29529, $4\frac{1}{2}$ inches long, from Ponapi, Caroline Islands. Five specimens, No. 08933, M. C. Z., 29506, $\frac{3}{4}$ to $2\frac{3}{4}$ inches long from Jaluit, Marshall Islands. Three specimens, Nos. 08884–6, $4\frac{1}{8}$ to $5\frac{1}{8}$ inches long, and two specimens, M. C. Z. 29509, 2 and $2\frac{7}{8}$ inches long from Suva, Fiji Islands. Ten specimens, 5 to $6\frac{3}{4}$ inches long, from Aitutaki, Cook Islands. Three specimens Nos. 08877, 08972, 08968, $2\frac{3}{8}$ to 3 inches long from Funafuti, Ellice Islands. Nine specimens, No. 08980, 1 to 2 inches long from Guam. Seventeen specimens from Tonga Islands, M. C. Z. 29479, 1 specimen, 14 specimens, M. C. Z. 29484, $\frac{1}{2}$ to $2\frac{3}{4}$ inches long from Eua, Friendly

Group, and No. A115, a specimen $9\frac{3}{4}$ inches long, No. 05817, $4\frac{1}{2}$ inches long, No. 08940, $4\frac{3}{4}$ inches long.

A115, has in upper lip a single row of outer close set teeth and behind these a band of slightly smaller teeth, close set and in several series; anal rays 9; scales 34, 11 in transverse series, pectoral pale, no axillary spot; at least the anterior third of anal in advance of soft dorsal.

Liza vaigiensis (Quoy & Gaimard).

Mugil vaigiensis Quoy & Gaimard, Voy. Uranie. Zool., 1825, p. 337, pl. 59, fig. 2.
Mugil waigiensis Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 218.

One specimen, No. 08827, 7 inches long from Suva, Fiji Islands. Three specimens, Nos. 08843, 08970–71, $2\frac{7}{16}$ to $3\frac{3}{4}$ inches long from Funafuti, Ellice Islands. Eight specimens, No. 09042, M. C. Z. 29478, 2 to $2\frac{1}{2}$ inches long from Marshall Islands. Four specimens No. 08984, M. C. Z. 29473, $1\frac{3}{8}$ to $1\frac{5}{8}$ inches long from Moen, Truk Group, Caroline Islands. Ten specimens from Paumotu Islands, seven of them No. 05815, $1\frac{5}{8}$ to $3\frac{7}{8}$ inches long from Makemo, and Nos. A28, $8\frac{1}{2}$ inches, A13, M. C. Z. 29785, $8\frac{5}{8}$ inches, and A26, $8\frac{1}{8}$ inches long from Rangiroa. No. A146, M. C. Z. 29781, a specimen 8 inches long from Suva, Fiji Islands.

In the A numbers the scales are 26 plus a few rudiments, 9 in cross series from front of dorsal to vent; minute wide set teeth in upper jaw in a single series; anal 8; all have black pectorals with lower part pale.

Four specimens from Tonga Islands, one of them, No. 05819, 3 inches long from Vavau, and three specimens $1\frac{3}{8}$ to $1\frac{5}{8}$ inches long from Tongatábu.

Fourteen specimens, No. 09016 (young), M. C. Z. 29531, from Guam.

L. vaigiensis and *L. melinopteras* are separated only by the numbers of anal rays, the former having eight and *L. melinopteras* having nine. The last anal ray is frequently divided to the base and it is difficult to say whether there are 8 or 9 rays. We do not believe the species different, Günther (Fische der Südsee) unites them.

The name *vaigiensis* has priority.

Liza borneensis (Bleeker).

Mugil borneensis Bleeker, Nat. Tijds. Ned. Ind., 1851, **2**, p. 201. Day, Fishes of India, 1876, p. 357, pl. 76, fig. 1.

One specimen, No. 08810, M. C. Z. 29794, $5\frac{1}{2}$ inches long (poor condition), from Kusaie, Caroline Islands. Three specimens from Vavau, Tonga Islands, No. A131, $5\frac{3}{4}$ inches long; No. 08893, $8\frac{1}{2}$ inches long, and No. A120, $11\frac{5}{8}$ inches long, No. A120 has teeth in two rows in upper jaw; dorsal IV–8; anal III, 9; scales 35, 11 in cross series. Nos. 08810 and A131, M. C. Z. 29778, show no teeth in upper jaw, the latter has 19 scales before dorsal, a moderately long axillary scale, otherwise it agrees very well with Day's description of *L. borneensis*.

Liza compressa (Günther).

Mugil compressus Günther, Cat., 1861, **3**, p. 51.

One specimen, No. 08815 (about 6 inches long), from Kusaie, Caroline Islands.

Liza crenilabis (Forskål).

Mugil crenilabis Forskål, Descrip. Anim., 1775, p. 73.
Querimana crenilabis, Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 218.

Four specimens, No. 08981, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches long from Guam. Four specimens, No. 05816, M. C. Z. 29376, $1\frac{3}{8}$ to $1\frac{7}{8}$ inches long from Makemo, Paumotu Islands.

No. A193, a specimen $8\frac{7}{8}$ inches long from Jaluit, Marshall Islands. No. A193 has head 4.66 in body; depth 4.17; eye 4 in head; dorsal IV–1, 8; anal III, 9 or 10; first dorsal midway between snout and base of caudal; origin of anal slightly in advance of dorsal; origin of first dorsal over 10th scale, second over 21st; a long scale in axil of pectoral and in axis of ventral and one on each side of spinous dorsal.

Neomyxus.

The genus Myxus based on *M. elongatus* Günther, Cat., 3, 466, has according to Günther "a single row of teeth on the upper jaw, sometimes in the lower and on the palate; upper lip not particularly thick."

Specimens in the U. S. National Museum from Bateman Bay, N. S. Wales, Australia, called *Myxus elongatus*, agree in having a moderately thick upper

lip, with a single row of teeth which are short, compressed and either rounded or slightly notched and slightly constricted at the base; lower lip with an outer fringe of fine simple cilia and some very much finer, scattered ciliae on its upper surface; many rows of small, sharp, curved teeth on vomer and palatines.

Chaenomugil of Gill is based on *Mugil proboscideus* Günther. The generic characters according to Gill, Proc. Acad. Nat. Sci., Phila., 1863, p. 169, are: "the longitudinal cleft of the mouth, the narrow and pointed lower jaw and the thick and angular upper lip"; the last of which is the only one in this description which actually separates it from Myxus.

In Fishes of the Hawaiian Islands, Jordan & Evermann give as generic characters of Chaenomugil, "Cleft of mouth lateral; lower jaw narrow; dentiform cilia in very many series, broad flat and somewhat paved; upper lip very thick; no adipose eyelid."

Species of *Chaenomugil proboscideus* in the U. S. National Museum collected at Mazatlan by Dr. Jordan, and probably identified by him, agree in the above characters and differ from *Myxus elongatus* in having no vomerine or palatine teeth; they also agree with the specific requirements of *C. proboscideus* as given by Günther.

In Fishes of Hawaiian Islands, Jordan & Evermann describe and figure a species which they identify as *Chaenomugil chaptali* and include in its synonymy *Myxus* (*Neomyxus*) *sclateri* Steindachner. They give another species which they identify as *Myxus pacificus* Steindachner, but in the synonymy of the genus Myxus they give Neomyxus Steindachner, based on *N. sclateri*.

Specimens in the U. S. Bureau of Fisheries reserve series, and U. S. National Museum labeled *Chaenomugil chaptali* from the Hawaiian Islands, being the specimens upon which Jordan & Evermann based their descriptions, agree neither with the generic requirements of Chaenomugil nor Myxus but agree perfectly with Steindachner's description of Myxus (*Neomyxus sclateri*) in which the rather slender labial ciliaform, pectinate, movable teeth are in two rows in each lip with sometimes a portion of a third row indicated. The character of these teeth, so widely different from those of Myxus, and the difference in the number of rows from those of Chaenomugil were indicated by Steindachner as sufficient basis for a new subgenus. We believe it, however, to be of generic value and that Neomyxus is a good genus.

In Fishes of Samoa, Jordan & Seale have represented the genus Myxus with one species, *M. leuciscus*, and Chaenomugil with two species, *C. chaptali* Eydoux & Souleyet and *C. nauticus* Bryan & Herre.

In the synonymy of *C. chaptali* they place *Myxus pacificus* Steindachner, and in a translation of Steindachner's description by Jordan & Evermann in Fishes of Hawaii, it is indicated that there are two rows of small movable teeth on the upper lip. Steindachner states that the intermaxillary has a band of small movable teeth in which those of the outer row are larger than those of the other rows; the border of the mandible is sharp, with a horizontal row of small movable teeth; he also distinctly states that the upper lip is rather small and the eye has a well developed adipose eyelid.

This last character removes it from Chaenomugil or Myxus. In the description of *Chaenomugil nauticus* Bryan & Herre, the teeth are not described with sufficient definiteness to indicate clearly whether it is a Chaenomugil or Neomyxus but the upper lips "not thick" would indicate that it belongs to the latter genus. Furthermore there is nothing in the description to indicate that it is not a Neomyxus. In the larger number of scales, large eye?, narrow interorbital, and long first ray of dorsal and of anal it seems to differ from any described species.

Neomyxus chaptali (Eydoux & Souleyet).

Mugil chaptali Eydoux & Souleyet, Voyage Bonite. Zool., 1842, **1**, p. 171, pl. 4, fig. 1.
Myxus (Neomyxus) sclateri Steindachner, Sitz Ak. Wiss. Wien, 1878, **77**, p. 384.
Chaenomugil chaptalii Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 40, fig. 49.

One specimen, No. 08834, $3\frac{1}{2}$ inches long from Funafuti, Ellice Islands, three specimens, No. 08981, each 2 inches long from Guam; three specimens; No. 08914, M. C. Z. 29514, $1\frac{3}{4}$ to 2 inches long from Arhno Atoll, Marshall Islands; twenty-two specimens, No. 05816, $1\frac{7}{8}$ to $2\frac{7}{8}$ inches long from Makemo, Paumotu Islands.

No. 08834 has head 3.73 in length; depth 4.17; eye 3.8 in head; interorbital 2.37; dorsal midway between snout and base of caudal; origin of anal one half in advance of dorsal; maxillary hidden; cilia in two rows in each jaw; dorsal IV–1, 9; A. II, I, 10; scales 13 or 14–44 or 45.

One of No. 05816, $2\frac{7}{8}$ inches long had head 3.65 in length, depth 4.2; eye 3 in head; dorsal midway between snout and base of caudal; anal origin $\frac{1}{2}$ in advance of dorsal; maxillary hidden; cilia in two rows in each jaw; dorsal IV–I, 9; anal II, I, 10; scales 13 or 14–45; preorbital serrated at extremity.

SPHYRAENIDAE.

Sphyraena obtusata Cuvier & Valenciennes.

Hist. Nat. Poiss., 1829, **3**, p. 350 (258).

Sphyraena forsteri Jordan & Seale, Bull. Bur. Fish., 1906, **25**, p. 219, not of Cuvier & Valenciennes.

One specimen, $1\frac{1}{2}$ inches long from Moen, Truk Group, Caroline Islands. Two specimens, No. A141, $14\frac{1}{2}$ inches long, and A142, 16 inches long, from Suva, Fiji Islands.

No. A141 M. C. Z. 29719, has 85 developed scales; two black spots on caudal peduncle on right side, the anterior of which is on lateral line, the posterior near the end of the series of large scales just above lateral line; on left side two spots, first on lateral line and second just below the lateral line and in line with front half of soft dorsal.

No. A142: Head 3.26 in length without caudal; eye 5.88 in head, equal to interorbital; snout 2.25; maxillary 2.12; mandible 1.49; dorsal V–I, 9; A. I, 8; developed scales in longitudinal series just above lateral line about 85. There are two spots on right side of caudal peduncle not so far back as in the other specimen, the posterior spot just below the lateral line; on the left side there is only one spot, on the caudal peduncle, the lower part of which touches the lateral line.

These specimens have been compared with a specimen about $9\frac{1}{2}$ inches long from Apia, Samoa, identified by Jordan & Seale as *Sphyraena forsteri*, and we can detect no differences except those that can be accounted for by the difference in size. It shows the following measurements:—

Head 3.17; depth 6.70; eye 5.70; snout 2.18; maxillary 2.18; mandible 1.50; interorbital 6.33; dorsal V–I, 9; anal I, 8; scales about 85.

The specimen which Jordan and Seale identified as *Sphyraena obtusata* is not available.

Sphyraena forsteri Cuvier & Valenciennes.

Hist. Nat. Poiss., 1829, **3**, p. 261 (353) and La Sphyrène de Forster, ibid., 1831, **7**, p. 382 (509). Bleeker, Nat. Tijds. Ned. Ind., 1852, **3**, p. 82.

Sphyraena toxeuma Fowler, Journ. Acad. Nat. Sci. Phila., 1904, ser. 2, **12**, p. 502, pl. 9, fig. 2 (middle).

One specimen, No. A140, $17\frac{3}{4}$ inches long from Suva, Fiji Islands.

This specimen agrees almost exactly with the description and figure of *Sphyraena toxeuma* Fowler (*loc. cit.*). Our specimen has 120 developed scales, but counting to a line across from origin of marginal caudal rays there are only 110.

Head from tip of snout 3.23 in length without caudal, from tip of lower jaw 2.97; eye 4.88 in head, considerably greater than interorbital, 2.28 in snout; maxillary not quite reaching eye, 2.21+ in head; mandible 1.46+; dorsal V–I, 10; anal II, 8; scales 13–120–13 (oblique rows counted downward and forward from front of first dorsal to and including the one in lateral line, and from lateral line to front of anal.

S. toxeuma is based on a specimen which Fowler considers specifically identical with a species described by Bleeker and referred with doubt to *S. forsteri*.

Fowler considers Günther's Südsee figure of a fish from Tahiti as certainly referable to *S. forsteri*. It shows more longitudinal scales and a much smaller eye.

S. forsteri of Günther, Cat., **2**, p. 337, is doubtless the same as Bleeker's, so far as the description indicates, but his figure in Südsee is of a different species with a much smaller eye. The statement in the description that the scales are 90 must be an error, as many more are shown in the figure.

The description of "*Sphyraena forsteri*" in Histoire Naturelle des Poissons, **3**, is based on a drawing made by Forster from a specimen taken at Otaiti, but the description is brief and insufficient and there is no character mentioned to distinguish it. It is stated, however, that the form is exactly that of the Sphyraena of Europe. In that species the eye is 8 in head and the scales 150 according to Cuvier & Valenciennes. But nothing indicates that these are so in *S. forsteri*. In the additions and corrections in vol. 7 (Hist. Nat. Poiss.), it is stated however that further specimens show that it is really different. Its dorsal and ventrals are advanced, as in *S. jello*, in front of the points of the pec-

toral, *the eye is very large*, therefore it would seem that if the name of Cuvier & Valenciennes is used it must be applied to a large-eyed species, such as *S. forsteri* of Bleeker, and of Günther Catalogue 2, and it will include *S. toxeuma* Fowler. But it is not *S. forsteri* of Günther's Südsee, with its small eye, accordingly the latter must be identified with some other species or be given a new name. It may be *Sphyraena jello* Cuvier & Valenciennes, with Day's description of which the figure agrees fairly well.

Sphyraena forsteri of Jordan & Seale, Fishes of Samoa is specifically identical with the form that we have identified with *S. obtusata*.

POLYNEMIDAE.

Polydactylus kuru (Bleeker).

Polynemus kuru Bleeker, Nat. Tijds. Ned. Ind., 1851, **2**, p. 600. Günther, Cat., 1860, **2**, p. 325.

Twenty-three specimens, No. 05836, M. C. Z. 29779, $2\frac{1}{4}$ to 8 inches long from Nukuhiva, Marquesas Islands. Dorsal VIII–I, 13; anal III, 11; scales about 60; pectoral filaments 6; caudal long, upper lobe 3.33 in total length.

FISTULARIDAE.

Fistularia petimba Lacépède.

Hist. Nat. Poiss., 1803, **5**, p. 349, 350.
Fistularia depressa Günther, Fische der Südsee, 1881, **7**, p. 221.

Twenty specimens (young), from Papeete, Tahiti, Society Islands. Two specimens, No. 09074 (small, dried up), from Arhno Atoll, Marshall Islands. One specimen, No. 08900, $8\frac{1}{2}$ inches long from Moen, Truk Group, Caroline Islands. No. 05810, $14\frac{1}{4}$ inches long from Vavau, Tonga Islands. No. 05812, $4\frac{1}{4}$ inches long from Suva, Fiji Islands. Three specimens from the Paumotu Islands as follows: Nos. A67, M. C. Z. 29724, 26 inches long, and A64, 26 inches long from Makemo; and 05811, $10\frac{1}{4}$ inches long from Fakarava.

SYNGNATHIDAE.

Corythroichthys conspicillatus (Jenyns).

Syngnathus conspicillatus Jenyns, Zool. Voy. Beagle. Fish, 1842, pt. 4, p. 147, pl. 27, fig. 4. Günther, Cat., 1870, **8**, p. 174.

Two specimens, No. 08929, a male $5\frac{1}{5}$ inches long and No. 08930, a female $5\frac{1}{2}$ inches long, from Jaluit, Marshall Islands.

The male specimen has dorsal 28; rings 17+37. The female specimen has dorsal 29; rings 17+36. M. C. Z. 29387.

Corythroichthys specifer (Rüppell).

Syngnathus specifer Rüppell, Neue Wirb. Fische, 1835, p. 143, taf. 33, fig. 4. Günther, Cat., 1870, **8**, p. 172.

One specimen, No. 08992, $5\frac{1}{16}$ inches long from Kusaie, Caroline Islands.

Microphis brachyurus (Bleeker).

Syngnathus brachyurus Bleeker, Verh. Bat. Genoot., 1853, **25**, p. 16. Nat. Tijds. Ned. Ind., 1854, **7**, p. 105. Günther, Cat., 1870, **8**, p. 184.

Two specimens, Nos. 08990–1, each $5\frac{1}{2}$ inches long from Kusaie, Caroline Islands.

No. 08990 has the rings 21+22; dorsal on $\frac{1}{2}$+8; dorsal rays 39; head 4+ in total length; snout not quite twice rest of head. No. 08991, M. C. Z. 29401, has the rings 21+23; dorsal on $\frac{1}{2}$+8; dorsal rays 42; head 4+ in total length; snout nearly twice rest of head.

Hippocampus guttulatus Cuvier.

Règne Anim. ed. 2, 1829, **2**, p. 363. Günther, Cat., 1870, **8**, p. 202.

One specimen, No. 09031, 4 inches long from Suva, Fiji Islands, an adult with pouch full of young.

Dorsal rays 17; body rings 11; branching filaments on the most prominent spines of head and body, some elsewhere over the body, these mostly simple. Color, uniform dark brown.

HOLOCENTRIDAE.

Holocentrus spinifer (Forskål).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 223.
Sciaena spinifer Forskål, Descript. Anim., 1775, p. 49.

No. A81, $12\frac{3}{4}$ inches long, from Makemo, Paumotu Islands.

Traces of red spots behind eye and base of pectoral; no distinct whitish spot on caudal peduncle above, but it is slightly lighter or silvery; preopercle very oblique; not vertical as in *H. caudimaculatus*.

Holocentrus tiereoides Bleeker.

Nat. Tijds. Ned. Ind., 1853, **5**, p. 334. Bryan & Herre, Occ. Papers Bishop Museum, 1903, **2**, p. 128.

No. 05844, $4\frac{3}{4}$ inches long, and No. 05845, $4\frac{1}{2}$ inches long from Papeete, Tahiti, Society Islands; No. 08966, $5\frac{1}{4}$ inches long from Jaluit, Marshall Islands.

Holocentrus punctatissimus Cuvier & Valenciennes.

Hist. Nat. Poiss., 1829, **3**, p. 160 (215). Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 224.

Nos. 05843, $2\frac{7}{8}$ inches long, 05841, 4 inches long, 05842, 4 inches and 05837, $4\frac{1}{2}$ inches, from Makemo, Paumotu Islands. M. C. Z. 29389.

Holocentrus diadema Lacépède.

Hist. Nat. Poiss., 1802, **4**, p. 335, 372, 374, pl. 32, fig. 3. Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 159, pl. 10.

One specimen, No. 05846, $2\frac{5}{8}$ inches long from Fakarava, Paumotu Islands.

Holocentrus sammara (Forskal).

Bleeker, Atlas Ichth., 1877–78, **9**, tab. 360, Trachichth. **6**, fig. 9 (figure only).
Sciaena sammara Forskål, Descript. Anim., 1775, p. 48.
Flammeo achromopterus Fowler, Proc. Acad. Nat. Sci. Phila., 1904, p. 236, fig. 6.

No. 08875, $5\frac{1}{2}$ inches long from Taritari, Gilbert Islands. Four specimens from Paumotu Islands, No. 05840, 6 inches long, and No. 05839, M. C. Z. 29372, $6\frac{1}{8}$ inches long from Makemo, and two specimens (young) from Fakarava.

Three specimens, Nos. 08869, 08870, 08871, $3\frac{5}{8}$, $5\frac{1}{4}$ and $5\frac{3}{4}$ inches long from Suva, Fiji Islands.

The two specimens from Makemo seem to be typically colored, except the dorsal which lacks the black spot on the front of spinous portion, but there is a faint suggestion of a dusky band below the upper margin of the membrane; and there are milky white blotches at the upper margin of the membrane immediately behind each spine. In this respect they agree with Bleeker's figure of this species in Atlas Ichth., 9, pl. 360, fig. 5.

The one from Taritari is much paler in color, the longitudinal bands hardly indicated, and those only on the back above the lateral line; faint spots on cheek and spinous dorsal similar to those above.

In reserve series of Bureau of Fisheries the specimens marked *H. laevis* from Dr. Jordan's Samoan collections, and regarding which he says there is never any black on spinous dorsal, two are similar in coloration to our pale examples of *H. sammara* from Makemo; one has a black blotch on the front of spinous dorsal, but is otherwise indistinguishable from the other specimens, except that the bands along the sides are a little more distinct than in the other two; we cannot separate them from *H. sammara*. In Fishes of Samoa, *H. thorntonensis* Fowler is included in synonymy of *H. sammara*, which cannot be correct if Fowler's figure can be relied upon, as it has with lower jaw included a very different head.

CARANGIDAE.

Scomberoides sanctipetri (Cuvier & Valenciennes).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 181.
Chorinemus sancti petri Cuv. & Val., Hist. Nat. Poiss., 1831, **8**, p. 279 (379), pl. 236.

No. A10, a specimen 19 inches long from Nukahiva, Marquesas Islands. Depth 4 in length to end of scales; head 5; eye (not orbit) 5 in head, about 1.5 in snout; maxillary reaches to posterior margin of eye; dorsal spines do not overlap, not reaching each other; dorsal VII, I, 20; anal II, I, 18; teeth in several series in upper jaw anteriorly, becoming two series posteriorly, the other series are the largest anteriorly, the inner is the larger of the two posterior series; in lower jaw the teeth are similar to those of upper jaw, but the

outer teeth are the smaller all the way around the jaw; soft dorsal with an outer, large dark brown blotch, covering most of the elongated portion of fin.

Scomberoides tolooparah (Cuvier).

Lichia toloo-parah Cuvier, Rüppell's Atlas, 1828, p. 91.

Two specimens, Nos. 08828, 08830, each 8 inches long from Suva, Fiji Islands.

Two specimens, No. 09003, $3\frac{1}{8}$ and $5\frac{1}{2}$ inches long from Rangiroa, Paumotu Islands. One specimen, No. 08848, $4\frac{1}{2}$ inches long from Vavau, Tonga Islands. No. 08978, $4\frac{1}{4}$ inches long from Funafuti, Ellice Islands. No. 09026, $2\frac{5}{8}$ inches long from Gilbert Islands. Six specimens from Nukuhiva, Marquesas Islands, M. C. Z. 29497 (3 specimens) as follows: Nos. 05795, three specimens 2 to $2\frac{1}{2}$ and 05825, three specimens $8\frac{1}{2}$, $9\frac{1}{2}$, and $9\frac{7}{8}$ inches long. Three specimens from Marshall Islands, as follows, Nos. 09065, $1\frac{1}{4}$ inches long from Arhno; 08932, $1\frac{5}{8}$ inches long from Jaluit; 09040, $1\frac{3}{4}$ inches long.

The $8\frac{1}{2}$ inch specimen has depth 3.41 in length; head 4.83; eye 4.23 in head; snout 3.6; maxillary reaching nearly to posterior margin of eye; dorsal VII, I, 20; anal II, I, 18.

The $9\frac{1}{2}$ inch specimen has depth 3.74 in length; head 4.92; eye 4.55 in head; snout 3.41; maxillary reaching to posterior margin of eye; dorsal VII, I, 21; anal II, I, 19.

The $9\frac{7}{8}$ inch specimen has depth 3.62 in length; head 4.88; eye 4.30 in head; snout 3.58; maxillary reaching to posterior margin of eye; dorsal VII, I, 19; anal II, I, 18. The seven dorsal spines include the first procumbent spine which is sometimes concealed under the skin, there are only 6 vertical spines, these all overlapping. The teeth in the upper jaw are in several rows anteriorly, two posteriorly, the outer teeth larger anteriorly and the inner posteriorly; in the lower jaw there are two rows for the entire extent of jaw, the outer of close set incisor-like teeth, the inner conical, not so close set; on each side of the symphysis of lower jaw are one or two enlarged canines in the inner row; a large dark brown blotch occupying the angle and greater portion of elongated part of soft dorsal.

We cannot distinguish these from *S. sanctipetri* except in depth and fewer dorsal rays in one specimen and the overlapping dorsal spines. Inasmuch as the

type of *S. sanctipetri* was a 20 inch specimen and the specimens described in the Hawaiian Fishes, $16\frac{1}{4}$ inches long and all the *S. tolooparah* in this latter work were of small size (1 to $10\frac{1}{4}$ inches), it suggests that *S. sanctipetri* is only the adult form of *S. tolooparah*.

Trachurops crumenophthalma (Bloch).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 230.
Scomber crumenophthalmus Bloch, Ichth., 1793, **10**, p. 65, pl. 343

Nos. A46, M. C. Z. 29780, and A45 each 9 inches long from Fakarava, Paumotu Islands.

Caranx melampygus Cuvier & Valenciennes.

Hist. Nat. Poiss., 1833, **9**, p. 87 (116). Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 230.

Fifteen specimens as follows from Vavau, Tonga Islands: Nos. 08890–92, three specimens $6\frac{5}{8}$ to 8 inches long, No. 05855, nine specimens $3\frac{1}{4}$ to $4\frac{1}{2}$ inches long, No. A126, M. C. Z. 29786, $8\frac{7}{8}$ inches long, No. A127, $11\frac{3}{4}$ inches long and No. A124, 13 inches long. Three specimens from Funafuti, Ellice Islands, Nos. 08979, $3\frac{3}{4}$ inches long, 08856, 08841, $3\frac{5}{8}$ and $6\frac{1}{2}$ inches long. Thirteen specimens from Paumotu Islands: Nos. 05854, M. C. Z. 29375, twelve specimens $3\frac{1}{2}$ to $4\frac{1}{2}$ inches long from Fakarava, and 05856, 5 inches long from Makemo. Two specimens No. 05857, $2\frac{5}{8}$ to $2\frac{7}{8}$ inches long from Bora Bora, Society Islands. One specimen, No. 08829, $8\frac{1}{2}$ inches long from Suva, Fiji Islands. One specimen, No. 09087 (part), 3 inches long from Marshall Islands. No. 05824, seventeen specimens, $2\frac{3}{4}$ to $8\frac{3}{4}$ inches long from Nukuhiva, Marquesas Islands. The smallest specimen has 5 or 6 broad dark cross bands. We are unable to identify these with any other species. They agree fairly well with *C. melampygus*, except that they lack the dark spots on the body.

Caranx forsteri Cuvier & Valenciennes.

Hist. Nat. Poiss., 1833, **9**, p. 81 (107).
Caranx hippos Günther, Cat., 1860, **2**, p. 449.

Two specimens, Nos. 08876–7, $7\frac{1}{2}$ and $9\frac{1}{4}$ inches long from Taritari, Gilbert Islands. Six specimens, Nos. 08851, 08845, M. C. Z. 29800, 08850, M. C. Z.

29800, 08844, M. C. Z. 29810, 08842, 08839, M. C. Z. 29800, 3 to $4\frac{3}{4}$ inches long from Funafuti, Ellice Islands. One specimen, No. 09087, $3\frac{1}{4}$ inches long from Marshall Islands.

Caranx ignobilis (Forskål).

Descript. Anim., 1775, p. 55. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 231.

Nos. A6, A8, A9, M. C. Z. 29751, each 14 inches long from Nukuhiva, Marquesas Islands.

There are about thirty-three scutes, counting all in straight portion of lateral line; there are more than twenty-seven shown in the figures of Rüppell (*C. sansun*) and Jordan & Evermann, when counted as above.

Caranx ferdau (Forskål).

Günther, Fische der Südsee, 1876, **5**, p. 134, taf. 87, 88.
Scomber ferdau Forskål, Descript. Anim., 1775, p. 55.
Carangoides ferdau Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 198, fig. 77.

No. A71, a specimen $13\frac{1}{5}$ inches long from Makemo, Paumotu Islands.

Head 3.42 in length to base of caudal; depth 2.43; eye 4.75 in head; snout 3.04; maxillary 2.53; pectoral 2.57 in length to base of caudal, slightly shorter than longest dorsal ray; base of dorsal 2.26 in length to base of caudal, slightly greater than its longest ray; longest anal ray 3.66; base of anal equal to pectoral; dorsal rays 31; anal 26; scutes 29 on right side, 25 on left.

Color: no spots now evident on body; axil of pectoral dusky; margin of soft anal pale.

This specimen is somewhat deeper than indicated by most descriptions and seems most like that represented by Günther's Südsee, plate 87; it also has many points in common with *Caranx gilberti* Jordan & Seale in Fishes Samoa, p. 234.

Trachinotus Lacépède.

Day's description and figure of *Trachynotus baillonii* do not agree. It is stated that "the maxillary nearly reaches to beneath the centre of the orbit," but in the figure it barely reaches the front of the eye. It is also stated that the

lobes of the dorsal and anal, if laid back, nearly reach the end of those fins. In the figure, the dorsal reaches about the middle and the anal a little beyond the middle. If the length of the lobes of dorsal and anal fin are of any importance, Day's figure of *T. baillonii* is certainly not the same as Rüppell's *C. quadripunctatus*, which in other respects it somewhat resembles; but Day's figure does not show as great length of vertical fin lobes as he indicated in the description, nor does it show them as long as those described by Lacépède, but the latter's figure is poor and does not show the fins as long as he describes them. Day's *T. russellii* agrees better with Lacépède's figure of *C. baillonii*. The lobes of the fin are not as long as Lacépède describes, but they are longer than Day's figure of *T. baillonii*, and the spots are much larger. Lacépède's description and poor figure of *C. baillonii* are insufficient for the identification of the species, but they show longer vertical fin lobes than are indicated by Cuvier & Valenciennes and by Day for this species, and in this respect they are much more like the *T. russelli* of Cuvier & Valenciennes and of Day.

Cuvier & Valenciennes record four species of this group of Trachinotus with black spots. Day includes them all in two species and Jordan & Seale recognize the same two species in Oceania. Under *T. russelli*, Jordan & Seale include *T. coppingeri* Günther. In the description and figure of this species Günther does not indicate that there are any spots.

Comparisons of the descriptions and figures indicate that the names have been incorrectly applied by Day, and his description and synonymy is somewhat mixed. Three of the four species mentioned by Cuvier & Valenciennes are valid. Day's *T. russellii* in part should become *T. baillonii* in the synonymy of which *T. russellii* of C. & V. should be placed, and Day's figure and part of his description of *T. baillonii*[1] is probably Cuvier & Valenciennes's *T. oblongus* to the synonymy of which *T. coppingeri* belongs, if it is a synonym of any species. There are thus in these waters three valid species with black spots: *T. baillonii* Lacépède, *T. quadripunctatus* Rüppell, *T. oblongus* Cuvier & Valenciennes.

In the collection there are two of the three species: *T. baillonii* and *T. oblongus*.

The three species may be separated by the following key which is made up from descriptions and figures and from specimens.

[1] To the synonymy of *T. quadripunctatus* (Rüppell) belongs *T. baillonii* Day in part, not figure.

A. Ventrals comparatively long; long dorsal and anal lobes.

B. Comparatively blunt muzzle, comparatively small eye; maxillary reaching front of pupil; body deep, 2.22 in length without caudal, *baillonii*.

BB. Comparatively sharp muzzle, large eye; maxillary reaching middle of eye; body more slender, 2.44 in length without caudal, *quadripunctatus*.

AA. Ventral fins comparatively short, comparatively short dorsal and anal lobes; muzzle rather sharp; eye large; maxillary short, reaching front of eye, *oblongus*.

Trachinotus ovatus (Linné).

Günther, Cat., 1860, **2**, p. 481. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 235.
Gasterosteus ovatus Linné, Syst. nat. ed. 10, 1758, p. 296.

No. A123, a specimen $8\frac{3}{4}$ inches long from Vavau, Tonga Islands.

Trachinotus baillonii (Lacépède).

Cuvier & Valenciennes, Hist. Nat. Poiss., 1831, **8**, p. 317, 319 (431).
Caesiomorus baillonii Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 92, 93, pl. 3, fig. 1.
Trachinotus russellii Cuv. & Val., Hist. Nat. Poiss., 1831, **8**, p. 320 (436). Day, Fishes of India, 1876, p. 233 (in part), pl. 51B, fig. 3.

Plate 2, figure 1.

Five specimens. Nos. 08987, M. C. Z. 29799, 08809, 08857, 08854, 08852, M. C. Z. 29799, $4\frac{3}{4}$ to $9\frac{7}{8}$ inches long from Funafuti, Ellice Islands.

No. 08857, $9\frac{7}{8}$ inches long, has head 4.28 in length; depth 2.22; eye 4.3 in head; snout 3.73; dorsal VI–I, 24; anal II–I, 23; scales about 90; lobe of soft dorsal 2.95 in length; lobe of anal 2.85 in length.

Color in spirits, silvery grayish on back, lobes of soft dorsal, anal, and caudal dusky; four spots on lateral line on right side, the anterior very small, next two half diameter of eye, the last minute; three spots on left side, first a little anterior to a line from last dorsal spine, .6 diameter of eye, next smaller, and last very small under posterior part of soft dorsal.

No. 08352, $5\frac{1}{8}$ inches long, has head 3.65 in length; depth 2.28; eye 3.71 in head; snout 4; dorsal lobe about 3.27 in length; anal 3.65; upper caudal lobe 2.87; lower 2.71; dorsal VI–I, 24; anal II–I, 24.

First rays of all fins dusky at tips; two very small dusky spots on each side of lateral line.

No. 08809, a small broken specimen, has dorsal VI–I, 23; anal II–I, 22; anal lobe reaches to last anal ray; black-tipped fins.

No. 08987, 4.75 inches long, has dorsal VI–I, 23?; anal II–I, 23; anal lobe reaches to posterior fifth of anal fin.

Trachinotus oblongus Cuvier & Valenciennes.

Hist. Nat. Poiss., 1831, **8**, p. 321 (437).

Trachynotus baillonii Day, Fishes of India, 1876, p. 233 (in part), and pl. 51A, fig. 1.

Trachynotus russellii Day, Fishes of India, 1876, p. 233 (in part), synonymy. Stead, Edible Fishes of New South Wales, 1908, p. 92, pl. 62.

Plate 1.

Seven specimens, Nos. A1–4, A5, 29733, 7 and 11, M. C. Z. 29734, from 10.5 to 12.5 inches long, from Nukuhiva, Marquesas Islands.

No. A1, M. C. Z. 29732, 11 inches long, has head 4.12 in length; depth 2.27; eye 3.42 in head; snout 4; dorsal VI–I, 24; anal II–I, 23; dorsal lobe 4.3 in length; anal lobe 4.12; each reaching slightly beyond middle of fins; scales about 97 or 98, counting all.

Color in spirits: general color silvery with grayish on back, one large black spot about size of eye on each side under the lobe of the dorsal and on lateral line; in front of this spot and just above middle of pectoral is a very faint spot, immediately above lateral line, its lower edge touching it.

No. A2, $10\frac{3}{4}$ inches long, has head 4.14 in length; depth 2.23; eye 3.76 in head; snout 4.08; lobe of soft dorsal 4.51 in length, 1.53 in its base; lobe of anal 4.41, 1.67 in its base; dorsal VI–I, 23; anal II–I, 23.

One large black spot on each side about in line with front rays of soft dorsal, .75 of the spot on one side and .66 of the spot on the other side above the lateral line diameter of the spot 1.3 in eye.

No. A3, $10\frac{5}{8}$ inches long, has dorsal VI–I, 23; anal II–I, 23; dorsal lobe 1.40 in base of dorsal fin; anal lobe 1.55 in the base of fin; two large black spots on right side of body, the greater portion of the anterior one above lateral line, and directly under sixth dorsal spine, its diameter about 1.3 in eye; a second spot under 11th dorsal ray, about .66 of it above lateral line; on left side one

large black spot about on a line just anterior to 6th dorsal spine; a very small spot partly on lateral line and under 11th dorsal ray.

No. A4, $10\frac{1}{8}$ inches long, has head 4.15 in length; depth 2.09; eye 3.83 in head; snout 3.83; dorsal VI–I, 24; anal II–I, 23; dorsal lobe 1.27 in dorsal base; anal lobe 1.36 in anal base. A large black spot on right side, about .66 of it above lateral line, its largest diameter about 1.08 in eye; situated about under middle of soft dorsal lobe; a small faint dusky spot just under 3d dorsal spine, partly on lateral line, but mostly above it; a similar large spot on left side and correspondingly located; a faint trace of very small black spot back of this and under 15th ray of dorsal.

No. A5, $9\frac{1}{2}$ inches long, has dorsal VI–I, 24; anal II–I, 23; dorsal lobe 1.52 in dorsal base; anal lobe 1.65 in anal base.

On the right side a very small spot under 3d dorsal spine; almost wholly above lateral line; a large black spot under middle of dorsal lobe, about .66 of the spot above lateral line, its diameter about 1.18 in eye; on left side a spot .38 of eye and under 3d dorsal spine, almost wholly above lateral line; another large one under middle of lobe of dorsal .84 of eye in diameter, about .6 of it above lateral line.

No. A7, $12\frac{1}{2}$ inches long has head 4.25 in length; depth 4.52; eye 3.7 in head; snout 4; maxillary 2.74; dorsal VI–I, 24; anal II–I, 24; lobe of dorsal 1.79 and of anal 1.70 in base of each fin respectively; scales 24–97–34.

On right side, a trace of a small spot below 2nd dorsal spine, entirely above lateral line; a large black one about size of eye, under anterior part of soft dorsal, about .6 of it above lateral line; another minute spot on lateral line about under 15th ray of dorsal; on left side is a small faint spot under 2d dorsal spine, wholly above lateral line; under anterior part of soft dorsal is a large spot, about .6 of it above lateral line, considerably larger than eye; a slight trace of a minute spot, entirely on lateral line and under 15th dorsal ray; another slight trace of a spot on lateral line on the middle of caudal peduncle, a similar one on right side; lobes of dorsal, anal, and caudal dusky.

No. A11, 11 inches long. On right side a spot almost wholly above lateral line and under 3d dorsal spine, small but distinct; a large spot about size of eye, under middle of dorsal lobe, about .6 of it above lateral line, on left side is the merest trace of a spot above lateral line and under first dorsal spine; a large

spot about size of eye, under anterior part of soft dorsal, about .66 of it above lateral line; merest trace of another spot under 15th dorsal ray and nearly on lateral line.

EQUULIDAE.

Leiognathus fasciatus (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 273.
Clupea fasciata Lacépède, Hist. Nat. Poiss., 1803, **5**, p. 425, 460, 463.

One specimen, No. 08816, 4 inches long from Suva, Fiji Islands.

Leiognathus splendens (Cuvier.)

Equula splendens Cuvier, Reg. Anim. ed. 2, 1829, **2**, p. 212. Day, Fishes of India, 1876, p. 239, pl. 52, fig. 3.

Two specimens, Nos. 08882, M. C. Z. 29795, 08826, $3\frac{3}{4}$ and $4\frac{1}{4}$ inches long from Suva, Fiji Islands.

Leiognathus edentula (Bloch).

Scomber edentulus Bloch, Ichth., 1795, **12**, taf. 428.
Equula edentula Day, Fishes of India, 1876, p. 238, pl. 52, fig. 1.

Five specimens (young) $1\frac{1}{8}$ to $1\frac{3}{4}$ inches long from Suva, Fiji Islands.

APOGONIDAE.

Apogon Lacépède.

In 1854 in Nat. Tijds. Ned. Ind. **6**, p. 321, Bleeker founded the genus Apogonichthys, basing it on *A. perdix* and giving, before his description of *A. perdix*, a list of species comprised in the new genus; *A. auritus* (Cuvier & Valenciennes, **7**, p. 332) heading this list.

The distinctive characters of Apogonichthys, he states, are the smooth preoperele and intramarginal crest, and the presence of palatine teeth. Later, in the description of *A. perdix* he states that the lateral line anteriorly consists of perceptible simple tubes and inconspicuous tubes posteriorly. Thus the only character wherein Apogonichthys differs from Apogon is in the smooth

preopercle and intramarginal crests. This character is not constant and we do not deem it of generic importance.

In 1903, in Bull. U. S. Fish. Comm., p. 180, Jordan & Evermann establish the genus Fowleria basing it on *A. auritus*, the first species Bleeker mentioned under his description of Apogonichthys. They state that Fowleria differs from Apogonichthys solely in the character of the lateral line, which is developed only on the anterior part of the body. This character does not separate Fowleria from Apogonichthys as defined by Bleeker. Cuvier & Valenciennes in the original description of *A. auritus* do not mention the lateral line or the palatine teeth. Should the palatine teeth prove to be absent, Fowleria could stand if based on the absence of palatine teeth.

In 1905, in Bull. U. S. Fish Comm., p. 210, Jordan & Evermann establish the genus Foa, basing it on *Fowleria brachygrammus* Jenkins, described on page 447, and state that "the genus differs from Amia [Apogon] only in the character of the lateral line which is developed only on the anterior part of the body, the preopercle being as in Mionorus without serrations * * * * and differing from Apogonichthys in having palatine teeth."

In 1906 in Fishes of Samoa, Bull. Bureau of Fisheries, page 248, Jordan & Seale still further characterize Foa, by the entire preopercle, incomplete lateral line and the presence of teeth on the palatines. In the same report, page 250, they place Fowleria in the synonymy of Apogonichthys, stating that Apogonichthys, "is based on a species *Apogon auritus* Cuvier & Valenciennes, which we have not seen. It is, however, very closely related to three Samoan species, with which it is doubtless congeneric. These species differ from the group called *Foa*, in having no teeth on the palatines. In all of them there is a large black ocellus on the opercle, and the lateral line, although interrupted, shows rudimentary pores on the caudal peduncle."

The characters given above for Foa are not different from those given by Bleeker for Apogonichthys and do not therefore separate it from Apogonichthys. If the three species mentioned above do not possess palatine teeth, they should be placed in the genus Fowleria and not in Apogonichthys since Apogonichthys possesses palatine teeth.

Jordan & Richardson, in Fishes of the Philippines, in Bull. U. S. Bur. Fish. 1908, 27, p. 255, state that "the original type of *Apogonichthys* Bleeker is *A.*

perdix Bleeker (Floris). This species has an incomplete lateral line, an entire preopercle and teeth on the palatines. The genus *Apogonichthys* is therefore the same as *Foa*, and *Fowleria* (*aurita*) is generically distinct." The validity of Fowleria depends upon whether *A. aurita* has palatine teeth.

Professor Vaillant has kindly examined the type of *Apogon auritus* in the Museum at Paris and states that there are teeth upon the vomer but none on the palatines, and that it can be said that it has palatal but not palatine teeth. Fowleria, based on the absence of palatine teeth, is therefore a valid genus.

Amia Gronovius, Zoophylaceum, 1763, p. 80 (nonbinomial).

Apogon Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 411 (*ruber*).

Apogonichthys Bleeker, Nat. Tijds, Ned. Ind., 1854, **6**, p. 321 (*perdix*).

Foa Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, 210 (*brachygrammus*).

Apogon frenatus Valenciennes.

Nouv. Ann. Mus. Hist. Nat., 1832, **1**, p. 57, pl. 4, fig. 4. Günther, Cat. 1859, **1**, p. 241. Günther, Fische der Südsee, 1873, **1**, p. 19, taf. 19, fig. A.

Amia frenata Bleeker, Atlas Ichth., 1876, **7**, p. 75, 89, **8**, tab. 342, Perc. 64, fig. 2.

Amia melanorhynchus Bleeker, Atlas Ichth., 1877, **8**, tab. 343, Perc. 65, fig. 1 (not description).

Apogon snyderi Jordan & Evermann, Bull. U. S. Fish Comm., 1903, **22**, p. 180.

One specimen, No. 05828, $3\frac{7}{8}$ inches long from Papeete, Tahiti, Society Islands.

We have carefully compared this specimen and specimens of *A. synderi* in the reserve series U. S. Bur. Fish. with Valenciennes's description and figure of *A. frenatus* and cannot find that they differ. Jordan & Evermann (*loc. cit.*) propose the name *A. synderi* for the fish which they say Günther in Südsee erroneously calls *A. frenatus*; they neglect, however, to say wherein Günther is in error. We find no discrepancies between figures and descriptions of Günther and Valenciennes, unless it be a slightly narrower lateral stripe in Valenciennes's figure, which we consider unimportant. Bleeker has a figure and description of *A. frenatus* which agrees with our specimens and which he says is the same as the *A. frenatus* of Günther's Catalogue, but not the same as the *A. frenatus* described and figured in his Südsee, the latter being according to Bleeker *A. fasciata*. But Bleeker's description and figure of *A. fasciata* do not agree;

the figure agrees in its serrations with *A. frenatus*, but not in its color; and in the description of *A. fasciatus* both the serrations and color certainly indicate a different species.

Bleeker figures a species which he calls *A. melanorhynchus*; the figure agrees with our specimens in serrations and color, but his description does not agree in the serrations. In the synonymy of this species he places *Apogon (Pristiapogon) frenatus* Klunzinger, and says "*melanorhynchus*, sometimes confounded with *frenata*, appears to me that it ought to be considered as a distinct species with a *chunkier* body and with the intramarginal preopercular crest smooth and the shoulder bone toothed and the *Apogon frenata* of Klünzinger from the Red Sea ought probably to be reported as *melanorhynchus*." But his figure shows *A. melanorhynchus* with intramarginal preopercular crest toothed as in *A. frenatus* of Valenciennes, and the shoulder bone toothed; in *A. frenatus* the shoulder bone is said to be smooth.

In his discussion of the genus *Apogon*, Day says "It seems also questionable whether any considerable value can be placed upon the serrations about the bones of the head, especially of the orbits, as such appear to be more distinct in some specimens than in others, and many vary with age."

In the seven specimens of *A. snyderi* in the U. S. Bur. Fish. reserve series, varying in size from $2\frac{7}{8}$ to $4\frac{5}{8}$ inches, the serrations of the preopercular margins and orbit are constantly present, but vary somewhat in amount in orbit. In some specimens the shoulder bone is serrated and in some it is not. We judge from this that the serration of the suprascapular or shoulder bone is without value.

Apogon orbicularis Kuhl & Van Hasselt.

Cuvier & Valenciennes, Hist. Nat. Poiss., 1828, **2**, p. 115 (155). Günther, Fische der Südsee, 1873, **1**, p. 22, taf. 20, fig. D. Day, Fishes of India, 1875, p. 65, pl. 17, fig. 7.

Seven specimens, No. 09080, 1 to $1\frac{1}{2}$ inches long, and No. 08909, M. C. Z. 29533 six specimens 1 inch long, from Moen, Truk Group, Caroline Islands.

Apogon savayensis (Günther).

Proc. Zool. Soc. Lond. 1871, p. 656. Fische der Südsee, 1873, **1**, p. 21, taf. 19, fig. B. Day, Fishes of India, 1875, p. 60, pl. 16, fig. 5.

Two specimens, No. 08942, M. C. Z. 29503 (1 specimen) $2\frac{1}{4}$ inches long, Kusaie, Caroline Islands.

Apogon ceramensis Bleeker.

Nat. Tijds. Ned. Ind., 1852, **3**, p. 256. Day, Fishes of India, 1875, p. 65, pl. 17, fig. 6.
Amia ceramensis Bleeker, Atlas Ichth., 1876, **7**, p. 75, 91; 1877, **8**, tab. 336, Perc. 58, fig. 1.

No. 08902, six specimens $\frac{3}{4}$ to 1 inch long and four specimens, No. 09083, M. C. Z. 29517, 1 to $1\frac{3}{4}$ inches long from Moen, Truk Group, Caroline Islands. Six specimens, No. 09049, 2 to $2\frac{1}{2}$ inches long from Suva, Fiji Islands. Five specimens, No. 09073, $\frac{23}{50}$ to $\frac{3}{4}$ of an inch long, from Arhno, Marshall Islands.

Apogon vaiulae (Jordan & Seale).

Foa vaiulae Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 249, fig. 43.

One specimen, No. 09030, $1\frac{5}{8}$ inches long from Suva, Fiji Islands.

We identify this specimen with *A. vaiulae* after having compared it with the type, although it is somewhat deeper and now shows no shoulder spot, otherwise it agrees perfectly. It is hardly possible that these slight differences, due to difference in size, are of importance.

Apogon exostigma (Jordan & Starks).

Amia exostigma Jordan & Starks, Bull. U. S. Bur. Fish., 1906, **25**, p. 238, fig. 31.

No. A87, a specimen $6\frac{1}{5}$ inches long from Makemo, Paumotu Islands.

Head 2.6 in length to base of caudal; depth 2.7; eye in head 3.84; snout 3.12; interorbital 4.54; maxillary+premaxillary 2.27; longest dorsal spine (3d) 1.78; ray 1.78; longest anal (2d) 5; dorsal VII, I, $9\frac{1}{2}$; anal II, $8\frac{1}{2}$; scales 3-25-5.

Preopercle and intraopercle coarsely serrated or toothed; shoulder bone or scale serrated; pectoral and ventral reaching anal; color same as that given by Jordan & Starks.

Apogon punctulatus Rüppell.

Neue Wirb. Fische, 1835, p. 88, tab. 22, fig. 4.
Apogonichthys marmoratus Jordan & Seale, Bull. Bur. Fish., 1906, **25**, p. 250, fig. 44.

One specimen, No. 05868, $1\frac{3}{8}$ inches long from Vavau, Tonga Islands.

Rüppell's description and figure of *A. punctulatus* do not admit of its being put in the synonymy of *A. auritus* of Day or *A. polystigma* of Bleeker. Rüppell says nothing of palatine teeth, and our specimen agrees very well with the specimens of *A. marmoratus* in the reserve series of the Bureau of Fisheries which are those recorded by Jordan & Seale in Fishes of Samoa. In all particulars our specimen agrees with Rüppell's description of *A. punctulatus*.

Mionorus waikiki (Jordan & Evermann).

Apogonichthys waikiki Jordan & Evermann, Bull. U. S. Fish Comm., 1903, **22**, p. 179.

One specimen, No. 09067, $\frac{5}{8}$ of an inch long from Arhno Atoll, Marshall Islands.

Head 2.33 in body; depth 2.8; eye 3; snout 3.42.

This specimen agrees with the description of *M. waikiki*, save for slight differences in color; there are no distinct bars on the fins, and the caudal is plain yellowish.

Paramia quinquelineata (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 252.
Cheilodipterus quinquelineata Cuv. & Val., Hist. Nat. Poiss., 1828, **2**, p. 124 (167).

No. 05829, a specimen $3\frac{1}{8}$ inches long from Papeete, Tahiti, Society Islands. No. 05830, two specimens $1\frac{3}{8}$ and $1\frac{3}{4}$ inches long from Vavau, Tonga Islands. M. C. Z. 29470.

AMBASSIDAE.

Ambassis urotaenia Bleeker.

Nat. Tijds. Ned. Ind., 1852, **3**, p. 257. Atlas Ichth., 1877, **8**, p. 133, 135, tab. 344, Perc. 66, fig. 2, and tab. 351, Perc. 73, fig. 1. Günther, Cat., 1859, **1**, p. 224.

Five specimens, No. 08800, 08994, 3 to 4 inches long from Kusaie, and No. 09093, 2 inches long from Ponapi, Caroline Islands. Twelve specimens, No. 08923, M. C. Z. 29486, $1\frac{3}{4}$ to 2 inches long from Suva, Fiji Islands.

KUHLIIDAE.

Kuhlia malo (Cuvier & Valenciennes).

Dules malo Cuv. & Val., Hist. Nat. Poiss., 1831, **7**, p. 360 (479). Dumont d'Urville, Voyage Pole Sud. Zool. Poissons, 1853, **3**, pl. 3, fig. 4.

Dules mato Lesson, Voyage Coquille. Zool., 1830, **2**, p. 223.

Dules leuciscus Jenyns, Zool. Voy. Beagle. Fish., 1842, pt. 4, p. 17.

Plate 2, figure 2.

Eight specimens, No. 05827, $3\frac{1}{2}$ to 6 inches long from Tipaerui River, Papeete, Society Islands, M. C. Z. 29367 (2 specimens).

The eight specimens are from the type locality of *K. malo*. The description of Cuvier & Valenciennes of *K. malo* agrees with our specimens, there being one character in particular,— the dorsal, anal, and ventral have brown spots, separated by whitish lines,— which agrees with our specimens and which emphasizes its separation from current descriptions of *K. malo*.

In the following, measurements are given of our largest specimen (160 mm.) and in parentheses the average measurements of the eight examples:

Head in length to base of caudal 3.39 (3. 30); depth 2.88 (2.85); eye in head 3.71 (3.338); snout 3.55 (3.73); maxillary 2.29 (2.346); interorbital 3.12 (3.475); soft dorsal base 1.69 (1.816); anal base 1.21 (1.336); longest dorsal spine (fifth) 2.05 (1.637); last dorsal spine 2.29 (2.168); longest anal spine (third) 2.60 (2.54); pectoral 1.5 (1.45); ventral 1.5 (1.45); dorsal IX, I, II; anal iii, 12 (11 rays in one specimen); scales 6 to 8–42–8 to 9.

General shape and appearance of *Pomoxis*; profile of head slightly concave; preorbital serrate; suborbital entire; preopercle finely serrate on both limbs, its ascending limb concave; maxillary reaching not quite to middle of eye; lower jaw slightly projecting. Scales large anteriorly, rapidly decreasing in size from a line in front of soft dorsal to base of caudal. Color in spirits, silvery gray; cheeks, throat, and breast with brassy reflections; body thickly covered with black spots about size of pupil, these chiefly above lateral line; narrow silvery interspaces giving a reticulated effect; tip of lower jaw black; tips of soft dorsal and anal white; interspinous dorsal membrane dusky, especially at the base and tips of the spines; the soft dorsal with rather large black spots

on the membranes with yellowish white interspaces and with a black anterior upper angle and margin; soft anal similarly colored with a row of black spots on scales at base; pectoral soiled yellowish externally, with a black base behind, and a dusky cross bar near the base; ventrals yellowish translucent with the outer membranes somewhat dusky; caudal with spots similar to soft vertical fins, the extremities of the caudal lobes black with narrow white margin on the upper and lower edges of the lobes; the ends of all the rays black making a narrow terminal margin of black.

Kuhlia maculata (Cuvier & Valenciennes).

Dules maculatus Cuv. & Val., Hist. Nat. Poiss., 1831, **7**, p. 357 (475).
? *Moronopsis ciliatus* Bleeker, Atlas Ichth., 1876, **7**, p. 120 (in part) tab. Perc., 38, fig. 1.

Plate 3, figure 1.

Eight specimens, Nos. 08996–99, 08802–3, 08805, 08832, 4 to $5\frac{3}{4}$ inches from Kusaie, Caroline Islands. M. C. Z. 29369 (2 specimens).

In the following, measurements are given of our largest specimen (145 mm.) and in parentheses the average measurements of the eight examples:

Head in length to base of caudal 3.28 (3.275); depth 2.67 (2.86); eye 2.91 (2.838); snout 4.12 (4.185); maxillary 2.33 (2.32); interorbital 3.5 (3.47); soft dorsal base 1.59 (1.675); anal base 1.20 (1.298); longest dorsal spine (fifth) 1.84 (1.81); last dorsal spine 2.50 (2.26); longest anal spine (third) 2.69 (2.59); pectoral 1.45 (1.47); ventral 1.45 (1.47); dorsal IX, I, 11, (12 rays in one specimen); anal iii, 11 in 3, 12 in 5 specimens; scales 5 or 6–42–7 or 8.

The shape and form of this species is similar to that of *K. malo*; preorbital serrated; preopercle finely serrated on its lower limb, the ascending limb entire, except at the upper end where there are a few minute teeth, and it is not concave.

General color of this species is the same as that of *K. malo*, but the dorsal differs in having the membrane of the spinous dorsal not so dusky and with no spots on soft dorsal or on scales at base; the soft dorsal is entirely dusky, most intense at upper anterior angle and along upper margin, with an indication of a longitudinal darker dusky band just above its base; the tips of rays are white; the fine scaly sheaths at the base of the soft dorsal and anal are dusky and without spots; the soft anal not spotted as it was in the other, but the rays are dusky,

most intense at about the middle of their length and near the ends; membrane between the spines and 1st ray entirely dusky and the middle duskiness of the other rays sometimes extends a little on the membranes presenting a sort of interrupted longitudinal band; margin of fin similar to that of the other specimen.

Bleeker's figure in Atlas Ichth., 8, Perc. tab. 46, fig. 2, resembles our specimens in shape, but the spots are scarcely indicated on the body and there are none on the dorsal, anal, or caudal. The description of *Perca ciliata* Kuhl & Van Hasselt in the Hist. Nat. Poiss., 2, p. 38, of Cuvier & Valenciennes, does not agree with our specimens. In the description of *Dules marginatus* Cuvier & Valenciennes, *ibid.*, p. 87, there are a few points that apply to our specimens, but in color ours bear no resemblance to the figure.

Kuhlia proxima, sp. nov.

Plate 3, figure 2.

Type No. 65889 U. S. N. M. (field no. 08920), 5 inches long from Fiji Islands. Cotype No. 29420 M. C. Z. (field No. 08919), $3\frac{3}{4}$ inches long from the same place.

Head 3; depth 2.60 in body; eye 2.53 in head; snout 4.12; maxillary 2.35; interorbital 3.66; base of soft dorsal 1.94; last dorsal spine 2.75; longest dorsal spine (fifth) 1.65; longest dorsal ray 1.94; base of anal 1.57; longest anal spine (third) 2.53; longest anal ray 2.53; pectoral 1.65; ventral 1.65 (not quite to vent); dorsal X, I, II; anal III, 11; scales 5 (6)–52–9. No. 08920 has D. IX, I, 11.

Body similar in shape to *K. sandvicensis*; eye large, snout short; maxillary reaching to anterior edge of pupil; lower jaw projecting; preopercle serrate on both limbs, its ascending limb not concave; preorbital serrate on its lower anterior edge; scales moderate, rather closely imbricated, decreasing in size to the base of the caudal.

Color generally silvery, darker on back; snout and lower jaw dusky; the membranes of spinous and soft dorsal and anal soiled dusky, extreme edge of dorsal black but not making a black border; a broad dusky terminal margin to the caudal, most intense at end of middle rays. This species differs from *K. sandvicensis* in the longer head; much larger eye; in having the ascending

limb of preopercle serrated, and fewer scales in transverse series; and a wider black terminal caudal margin. It differs from *K. marginata* from Samoa in having more scales in longitudinal series. It lacks the black margin on soft dorsal and anal; and it has a much larger eye; *K. marginata* does not have serrations on the ascending limb of preopercle. It is close to *Dules humilis* of De Vis from Queensland, differing in having a larger eye, shorter snout, and longer third anal spine. In *D. humilis* the second anal spine is as long as and stronger than the third.

Kuhlia sandvicensis (Steindachner).

Moronopsis argenteus var. *sandvicensis* Steindachner, Sitz. Ak. Wiss. Wein, 1876, **74**, p. 205 (Beitrage **5**, p. 158).

Moronopsis sandvicensis Steindachner, Sitz. Ak. Wiss. Wein, 1887, **96**, p. 56 (Beitrage **14**, p. 1), taf. 1, fig. 1.

Seven specimens, No. 05826, 2 to $5\frac{1}{2}$ inches long from Makemo, Paumotu Islands. M. C. Z. 29498 (2 specimens). One specimen (no number) $1\frac{1}{2}$ inches long from Makatea, Paumotu Islands.

These specimens appear a little deeper than some from Hawaii but their measurements do not show it.

Kuhlia rupestris (Lacépède).

Centropomus rupestris Lacépède, Hist. Nat. Poiss., 1802, **4**, p. 252, 272

Dules haswellii Macleay, Proc. Linn. Soc. N. S. Wales, 1881, **5**, p. 359.

Nos. 08804, M. C. Z. 29458, a specimen 5 in. long, 08807, a specimen $6\frac{3}{8}$ in. long, 08806, a specimen $6\frac{1}{4}$ in. long, 08995, a specimen 3 in. long, all from Kusaie, Caroline Islands.

Easily distinguished from *K. maculatus* by the much larger mouth and longer maxillary, which extends to middle of eye, and also by the differences in coloration.

Kuhlia taeniura (Cuvier & Valenciennes).

Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 208, fig. 81.

Dules taeniurus Cuv. & Val., Hist. Nat. Poiss., 1829, **3**, p. 85 (114).

Fourteen specimens, No. 08917, $1\frac{3}{4}$ to $1\frac{1}{8}$ inches long from Arhno Atoll, Marshall Islands.

Two specimens, Nos. 08918, and 09039, M. C. Z. 29505, $3\frac{1}{8}$ inches long from Marshall Islands.

SERRANIDAE.

Paracanthistius maculatus (Bloch).

Bleeker, Atlas Ichth., 1876, **7**, p. 25, 26.

Bodianus maculatus Bloch, Ausl. Fische, 1790, **4**, p. 48, pl. 228.

One example, No. A151, 15 inches long, from Funafuti, Ellice Islands.

Head and body spotted; the only spaces without spots are just in front of the vent and just in front of anal; spots all round, none oblong.

Anyperodon leucogrammicus (Cuvier & Valenciennes).

Bleeker, Atlas Ichth., 1876, **7**, p. 28, Nat. tab. 279, Perc. 1, fig. 4.

Serranus leucogrammicus Cuv. & Val., Hist. Nat. Poiss., 1828, **2**, p. 259 (347).

One specimen, No. A153, about 12 inches long, from Funafuti, Ellice Islands.

Cephalopholis argus Bloch & Schneider.

Syst. Ichth., 1801, p. 311.

Serranus guttatus (part) Day, Fishes of India, 1875, p. 24.

Epinephelus argus Bleeker, Atlas Ichth., 1876, **7**, p. 32, 43, tab. 313, Perc. 64, fig. 3. Boulenger, Cat., 1895, **1**, p. 189.

Three specimens from Jaluit, Marshall Islands, Nos. 08860, $7\frac{1}{4}$ inches long; 08916, 3 inches long and A191, $10\frac{1}{4}$ inches long. Nos. A173, $9\frac{3}{8}$ inches long, and A169, M. C. Z. 29787, $7\frac{1}{8}$ inches long, from Taritari, Gilbert Islands. Nos. A25, M. C. Z. 29742, 12 inches long, and A17, from Rangiroa, Paumotu Islands. Nos. A152, $12\frac{1}{2}$ inches long, and A154, M. C. Z. 29743, $11\frac{1}{4}$ inches long, from Funafuti, Ellice Islands. On all the A numbered specimens there are about 8 cross bands on body, especially distinct posteriorly, each about half as wide as interspaces.

Cephalopholis urodelus (Cuvier & Valenciennes).

Serranus urodelus Cuv. & Val., Hist. Nat. Poiss., 1828, **2**, p. 227 (306). Günther, Fische der Südsee, 1873, **1**, p. 3, fig. A.

Epinephelus urodelus Boulenger (form A), Cat., 1895, **1**, p. 192.

No. 08961, a specimen $5\frac{4}{5}$ inches long from Jaluit, Marshall Islands.

Cephalopholis leopardus (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 258.
Labrus leopardus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 518, 521, pl. 30, fig. 1.

No. A179, a specimen $5\frac{1}{2}$ inches long from Arhno, Marshall Islands, and M. C. Z. 29463, A186, $4\frac{3}{8}$ inches long from Jaluit, Marshall Islands.

Ephinephelus merra Bloch.

Ausl. Fische., 1793, **7**, p. 17, pl. 329. Boulenger, Cat., 1895, **1**, p. 241 (form B).
Serranus hexagonatus Day, Fishes of India, 1875, p. 14, pl. 2, fig. 3.
Epinephelus stellans Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 258.

Six specimens from Paumotu Islands, Nos. 05864, $6\frac{1}{2}$ inches long, A62, 9 inches, A94 M. C. Z. 29796 $7\frac{3}{4}$ inches, A61, $7\frac{1}{2}$ inches, all from Makemo, 05867, $1\frac{7}{8}$ inches long and A27, $8\frac{3}{4}$ inches long from Rangiroa. No. 05866, $5\frac{1}{2}$ inches long from Tahiti, Society Islands. No. A185, M. C. Z. 29797, $6\frac{1}{4}$ inches long from Jaluit, Marshall Islands.

Epinephelus fuscoguttatus (Forskål).

Bleeker, Atlas Ichth., 1876, **7**, p. 34, 57, tab. 307, Perc. 29, fig. 3. Boulenger, Cat., 1895, **1**, p. 249.
Perca summana var. *fuscoguttata* Forskål, Descript. Anim., 1775, p. 42.

Five specimens from Paumotu Islands, Nos. A93, $8\frac{1}{4}$ inches long, A77, $9\frac{1}{4}$ inches long, A96, $9\frac{3}{4}$ inches long, A75, M. C. Z. 29722, $9\frac{3}{4}$ inches long and 05865, M. C. Z. 29384, $8\frac{1}{2}$ inches long, all from Makemo; A155, 10 inches long from Funafuti, Ellice Islands; A177, 14 inches long from Rongelab, Marshall Islands. A12, M. C. Z. 29721, Rangiroa, Paumotu Islands.

Epinephelus caeruleopunctatus (Bloch).

Boulenger, Cat., 1895, **1**, p. 246.
Holocentrus caeruleopunctatus Bloch, Ausl. Fische, 1790, **4**, p. 94, tab. 242, fig. 2

No. 08928, a specimen $7\frac{1}{4}$ inches long from Jaluit, Marshall Islands.

PRIACANTHIDAE.

Priacanthus cruentatus (Lacépède).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 229.
Labrus cruentatus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 522

No. 05858, a specimen $8\frac{1}{2}$ inches long from Papeete, Tahiti, Society Islands.

LUTIANIDAE.

Lutianus kasmira (Forskål).

Sciaena kasmira Forskål, Descript. Anim., 1775, p. 46.
Holocentrus bengalensis Bloch, Ausl. Fische, 1790, **4**, p. 7, Ichth., p. 82, taf. 246, fig. 2.
Lutianus bengalensis Day, Fishes of India, 1875, p. 33, pl. 10, fig 4. Bleeker, Atlas Ichth. 1877, **8**, p. 44, 55, 333, Perc. 55, fig. 4.

No. 08865, 5 inches long from Suva, Fiji Islands. This specimen has but 10 dorsal spines, differing from Bloch and Day, who each give 11 dorsal spines. Bleeker found 10 or 11 spines in the dorsal.

Lutianus gibbus (Forskål).

Day, Fishes of India, 1875, p. 43, pl. 13, fig. 2, 3.
Sciaena gibba Forskål, Descript. Anim., 1775, p. 46.

Two specimens, Nos. 08866, 5 inches long, and 08868, $5\frac{3}{4}$ inches long from Suva, Fiji Islands. Four specimens from Paumotu Islands, Nos. A19, 14 inches and A22, M. C. Z. 29741, $14\frac{1}{2}$ inches long from Rangiroa, A66, $14\frac{3}{4}$ inches long from Makemo, and A41, M. C. Z. 29758, 9 inches long from Fakarava. No. 108, M. C. Z. 29757, $9\frac{3}{4}$ inches long from Takaa, Society Islands. No. A166, $5\frac{3}{4}$ inches long from Taritari, Gilbert Islands. Two specimens from Marshall Islands, Nos. A176, 13 inches long from Rongelab and A183, $14\frac{1}{4}$ inches long from Arhno Atoll.

Lutianus marginatus (Cuvier & Valenciennes).

Day, Fishes of India, 1875, p. 44, pl. 13, fig. 5.
Diacope marginata Cuv. & Val., Hist. Nat. Poiss., 1828, **2**, p. 320 (425).

No. 05869, $7\frac{1}{4}$ inches long from Makemo, Paumotu Islands. No. 05871, $3\frac{1}{4}$ inches long, Bora Bora, Society Islands. Three specimens from Caroline

Islands, Nos. 09021, 08814, $6\frac{1}{2}$ and $8\frac{1}{4}$ inches long, from Kusaie, and 09011, $1\frac{3}{8}$ inches long from Truk Group. Two specimens, Nos. 09038, 1 and $1\frac{1}{4}$ inches long from Arhno Atoll, Marshall Islands, Nos. A137, M. C. Z. 29728 10 inches long and A138, $11\frac{1}{4}$ inches long from Suva, Fiji Islands. No. A158, M. C. Z. 29729, $8\frac{3}{4}$ inches long from Taritari, Gilbert Islands.

Lutianus johnii (Bloch).

Day, Fishes of India, 1875, p. 42, pl. 13, fig. 1.
Anthias johnii Bloch, Ichth., 1793, **9**, p. 97, tab. 318.

One specimen, No. 08921, 5.75 inches long, from Suva, Fiji Islands. No. 09050, M. C. Z. 29398, 1.75 inches long from Moen, Truk Group, Caroline Islands. This small specimen is somewhat mutilated and no teeth can be detected on its tongue; otherwise it agrees with *L. johnii*, and is with some doubt, identified as that species.

Lutianus monostigma (Cuvier & Valenciennes).

Mesoprion monostigma Cuv. & Val., Hist. Nat. Poiss., 1828, **2**, p. 337 (446). Günther, Fische der Südsee, 1873, **1**, p. 14, taf. 16.
Lutjanus lioglossus Bleeker, Atlas Ichth., 1877, **8**, 46, 70, tab. 344, Perc. 66, fig. 4.

Seven specimens from Paumotu Islands: Nos. 08823, $5\frac{1}{2}$ inches long from Anaa, one specimen 5 inches long and A92, M. C. Z. 29768, $7\frac{1}{8}$ inches, A99, $8\frac{5}{8}$ inches, A100, M. C. Z. 29769, 8 inches from Makemo, and A35, $8\frac{5}{8}$ inches, 05861, $5\frac{1}{4}$ inches from Makatea. Five specimens, Nos. 08986, $1\frac{1}{2}$ to $3\frac{1}{4}$ inches long from Moen, Truk Group, Caroline Islands. No. A168, 8 inches long from Taritari, Gilbert Islands.

Lutianus marginatoides, spec. nov.

Plate 4, figure 1.

Type No. 68943 U. S. N. M. (field No. A74), $8\frac{1}{4}$ inches long from Makemo, Paumotu Islands.

Head to tip of flaps 2.57 in body; depth 2.39; eye 5.07 in head; snout 3; maxillary 2.69, reaching to front of pupil; mandible 2.49; interorbital 4.71; pectoral 1.26, reaching beyond ventrals to a line from base of last dorsal spine;

ventrals 1.59, reaching just to vent; dorsal X, 13½, fourth spine longest, longest ray 3.5 in head; anal III, 8, second anal spine longest, 2.85 in head, longest ray 2.35 in head; preopercle strongly notched; a conspicuous knob on opercle; six rows of scales on cheeks; scales above lateral line in oblique series; counting from front of dorsal to lateral line there are 8 scales, from anal to lateral line 13, scales above lateral line 54, below 48, the formulae being 8–48 to 54–13; no lingual teeth.

Color, greenish gray on back, lighter line of same color on side and belly; dorsal yellowish with light green spines and dusky spines and rays and a broad white-edged dusky margin; caudal very dusky with a narrow white terminal margin, more distinct in middle; other fins all paler; faint light streaks following rows of scales, running obliquely upward and backward above lateral line, horizontally below.

This is close to *L. marginata* but differs in having a considerably smaller eye and somewhat smaller mouth, and it may be *Diacope striata* or *D. axillaris* of Cuvier & Valenciennes, but the descriptions are too incomplete to make the identification certain.

THERAPONIDAE.

Therapon maculatus, spec. nov.

Plate 4, figure 2.

Eight specimens, No. 08924, 2 to 5 inches long from Suva, Fiji Islands. M. C. Z. 29494 (2 specimens).

Type, No. 66061 U. S. N. M., 5 inches long, has head 2.86 in length; depth 2.71; eye 3.60 in head; snout 2.5; maxillary 3.27; dorsal XII, 11; anal III, 9½; scales 11–60(+9)–18; 11 scales from front of dorsal to lateral line and 18 from lateral line to anal.

Longest dorsal spine 2 in head; second anal spine longest, 1.89 in head; preopercle strongly denticulate above angle; fine teeth on lower margin; teeth in upper jaw in many villiform bands in front, the band changing into about 3 rows posteriorly; an anterior row of enlarged mixed, incisor-like and canine-like or curved backward conical teeth, the latter longer than the others; lower

jaw with several rows of viliform teeth in front, these becoming 2 rows posteriorly; outer row larger and conical but not so large as in upper jaw.

Color after a long time (9 years) in alcohol, body dark gray with slight reddish tinge; dark on back and still darker on top of head and snout, covered with faint brown spots, one third diameter of eye, approximately arranged in longitudinal rows and faintly evident on caudal fin; each scale with a small silvery spot making narrow longitudinal silvery streaks or lines; pectoral dusky; ventral black except at base and on last or inner ray where it is white; spinous dorsal clouded with purplish brown, each interspinous membrane with black margin which is most evident next to spine in front; soft dorsal margined with dark brown at its upper anterior margin; anal membrane very dark brown, most intense anteriorly.

Therapon jarbua (Forskål).

Day, Fishes of India, 1875, p. 69, pl. 18, fig. 4.
Sciaena jarbua Forskål, Descript. Anim., 1775, p. 50.

Six specimens from Suva, Fiji Islands, Nos. 08831, 7½ inches, 08821, 5 inches, 08883, 3¼ inches, 08922, 5¼ inches, 08889, 7 inches and A144, 8¾ inches. Three specimens from Tonga Islands, Nos. 05862, M. C. Z. 29577, 4½ inches from Vavau and 05863, M. C. Z. 29578, 08941, M. C. Z. 29373, 5¼ and 7 inches long from Tongatábu.

SPARIDAE.

Lethrinus ramak (Forskål).

Günther, Fische der Südsee, 1874, **3**, p. 69, taf. 46, fig. B. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 269.
Sciaena ramak Forskål, Descript. Anim., 1775, p. 53.

Four specimens from Taritari, Gilbert Islands, Nos. A159, 10 inches, A165, M. C. Z. 29727, 6½ inches, A170, M. C. Z. 29726, 10⅜ inches, A172, 7½ inches.

Lethrinus harak (Forskål).

Day, Fishes of India, 1875, p. 137, pl. 33, fig. 3.
Sciaena harak Forskål, Descript. Anim., 1775, p. 52.

Two specimens, Nos. A143, and 08833, M. C. Z. 29419 (1 specimen), 6½ inches long from Suva, Fiji. Three specimens, Nos. 08935, 9½ inches, 08934,

M. C. Z. 29775, $7\frac{5}{8}$ inches, and A198, M. C. Z. 29723, $9\frac{1}{2}$ inches long from Kusaie, Caroline Islands. One specimen, No. 08896, $7\frac{3}{16}$ inches long from Vavau, Tonga Islands.

The specimens from Kusaie have a large dusky oblong spot below lateral line above end of pectoral; axil very dark.

In No. A143 the dusky lateral spot is wanting on right side, with possibly a faint trace on left; axil not so dusky, otherwise no distinguishable differences.

No. 08896, in addition to the lateral spot it has traces of 8 or 9 cross bars on body, which extend on to the side of the abdomen, about on a line with lower base of pectoral.

Lethrinus mahsenoides Ehrenberg.

Cuvier & Valenciennes's, Hist. Nat. Poiss., 1830, **6**, p. 212 (286). Günther, Cat., 1859, **1**, p. 464 Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 270.

Two specimens Nos. 08894 M. C. Z. 29782 and 08895, $7\frac{1}{4}$ and 7 inches long respectively, from Vavau, Tonga Islands.

No. 08894 had head 2.96 in length; depth 2.69; eye 3.85 in head; snout 2.08; preorbital 2.63; pectoral 3.44 in length; ventral 4.48; longest dorsal spine (4th) 7.79; dorsal X, 9; anal III, 8; scales 6–49–16.

No. 08895 had head 2.95 in length; depth 2.68; eye 3.84 in head; snout 2.18; preorbital 2.82; pectoral 3.46 in length; ventral 4.73; longest dorsal spine (4th) 8.35; dorsal X, 9; anal III, 8; scales 6–49–16.

Head grayish with brownish shades; gill membrane margined with red, still showing quite plainly; body grayish, darker on back, paler on belly; traces of 8 or 9 narrow dusky half bars running somewhat obliquely downward and backward; many scales on back and side, each with a white or pale center; pectoral yellowish; ventral greenish with dusky tips; dorsal and anal with traces of narrow horizontal or oblique narrow bars; caudal yellowish with traces of about 4 broad cross bars.

Lethrinus moensii Bleeker.

Nat. Tijds. Ned. Ind., 1855, **9**, p. 435. Günther, Fische der Südsee, 1874, **3**, p. 64, taf. 46, fig. A. Bleeker, Atlas Ichth., 1877, **8**, p. 115, **7**, tab. 297, Perc. 19, fig. 3.

No. 08867, $4\frac{4}{5}$ inches long, from Suva, Fiji Islands. The specimen is dried and in bad condition; it does not show any color markings. It seems nearer to this species than to any other and is without much doubt correctly identified.

Lethrinus richardsonii Günther.

Cat., 1859, **1**, p. 456.

Six specimens, No. 08903, $\frac{7}{8}$ to 2 inches long, from Truk Group, Caroline Islands. These specimens are in bad condition, but the color markings show fairly well. No. 05870, 5 inches long, and one specimen $2\frac{1}{8}$ inches long, from Vavau, Tonga Islands.

Lethrinella miniata (Forster).

Fowler, Journ. Acad. Nat. Sci. Phila., 1904, ser. 2, **12**, p. 529.
Sparus miniatus Forster, Bloch. & Schneider's Ichth., 1801, p. 281.

No. A14, M. C. Z. 29748, about 16 inches long from Rangiroa, Paumotu Islands and No. A58, about $17\frac{3}{4}$ inches long, from Fakarava, Paumotu Islands.

Monotaxis grandoculis (Forskål).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 271.
Sciaena grandoculis Forskål, Descript. Animal, 1775, p. 53.

One specimen, No. A181, $9\frac{7}{8}$ inches long from Arhno, Marshall Islands.

GERRIDAE.

Xystaema argyreum (Forster).

Sciaena argyrea Forster, Bloch & Schneider's Syst. Ichth., 1801, p. 344. Descript. Anim. Ed. Lichtenstein, 1844, p. 291.
Gerres argyreus Günther, Cat., 1859, **1**, p. 353; 1862, **4**, p. 263.

One specimen, No. 08855, $6\frac{1}{4}$ inches long from Funafuti, Ellice Islands.

From the descriptions it is difficult to distinguish this species from *gigas*.

Xystaema acinaces (Bleeker).

Gerres acinaces Bleeker, Nat. Tijds. Ned. Ind., 1854, **6**, p. 194.
Diapterus acinaces Bleeker, Atlas Ichth., 1877, **8**, p. 123–126, tab. 361, Perc. 77, fig. 2.

Three specimens, Nos. 08853, $4\frac{3}{4}$ inches, 08973, $3\frac{3}{4}$ inches, 08846, $4\frac{1}{2}$ inches long from Funafuti, Ellice Islands.

Two specimens from Vavau, Tonga Islands, Nos. A128, about 7 inches long, and A129, M. C. Z. 29293 $5\frac{1}{2}$ inches long.

These agree with Bleeker's description and the plate in Atlas, excepting that our specimen has traces of small dusky spots on the dorsal spines. These specimens are too deep for *X. argyreum* or *X. macrosoma*.

Xystaema oyena (Forskål).

Labrus oyena Forskål, Descrip. Anim., 1775, p. 35.
Gerres oyena Day, Fishes of India, 1875, p. 99, pl. 25, fig. 4.
Diapterus oyena Bleeker, Atlas Ichth., 1877, **8**, p. 124, 129, tab. 361, Pere. 77, fig. 5.

Nos. 09019, nineteen specimens, $2\frac{1}{4}$ to 3 inches long, and 09047, five specimens, $1\frac{1}{2}$ to 3 inches long from Suva, Fiji Islands. Seven specimens from Tonga Islands, one a specimen, M. C. Z. 29388, $5\frac{1}{2}$ inches long from Tongatábu; 5 specimens, No. 05886, 4 to $4\frac{1}{4}$ inches long, and one, No. 05887, $3\frac{1}{4}$ inches long from Vavau. M. C. Z. 29461, No. 08982, three specimens, 2 to $3\frac{3}{4}$ inches long, from Guam. Nos. 09053, seven specimens 1 to $1\frac{3}{4}$ inches long from Truk, Caroline Islands, and 09081, seven specimens $1\frac{1}{2}$ to $1\frac{3}{4}$ inches long from Moen, Caroline Islands.

It is difficult to identify these fishes with any degree of certainty on account of their poor condition and the small size of most of the specimens. According to descriptions they seem to be closely related to *X. limbatus* and *X. kapas*, but they agree best with *X. oyena*. The black on the caudal is more evident in some than in others, but in all, traces of black are evident. They are more remote from *X. argyreum*, the latter being a slender fish.

MULLIDAE.

Upeneus vittatus (Forskål).

Bleeker, Atlas Ichth., 1877–78, **9**, tab. 392, Mull., fig. 3. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 273.
Mullus vittatus Forskål, Descript. Anim., 1775, p. 31.

No. A145, about $7\frac{1}{2}$ inches long, from Suva, Fiji Islands.

Black blotch covering membrane at upper angle of spinous dorsal from first to tip of fifth spine; front tip of soft dorsal with black blotch.

This specimen agrees perfectly with Bleeker's figure.

Teeth in both jaws, vomer and palatines not in villiform bands, but very blunt teeth in several rows; lateral line 37.

Upeneus sulphureus Cuvier & Valenciennes.

Hist. Nat. Poiss., 1829, **3**, p. 331 (450). Bleeker, Atlas Ichth., 1877–78, **9**, tab. 393, Mull. 3, fig. 4.
Upeneoides sulphureus Günther, Cat. 1859, **1**, p. 398. Day, Fishes of India, 1875, p. 120, pl. 30, fig. 3.

No. 08820, a specimen $4\frac{1}{2}$ inches long from Suva, Fiji Islands.

Pseudupeneus moana Jordan & Snyder.

Proc. U. S. Nat. Mus., 1905, **29**, p. 354. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 274.

One specimen, No. 08948, $4\frac{1}{2}$ inches long from Kusaie, Caroline Islands.

Pseudupeneus bifasciatus (Lacépède).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 258, fig. 107.
Mullus bifasciatus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 404, pl. 14, fig. 2.

One specimen No. 05847, $7\frac{5}{8}$ inches long from Papeete, Tahiti, Society Islands.

Pseudupeneus barberinus (Lacépède).

Mullus barberinus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 406, pl. 13, fig. 3.
Upeneus barberinus Cuvier & Valenciennes, Hist. Nat. Poiss., 1829, **3**, p. 340 (642). Günther, Fische der Südsee, 1874, **2**, p. 57, taf. 42.
Parupeneus barberinus Bleeker, Atlas Ichth., 1877, **8**, tab. 393, Mull. 3, fig. 1.

One specimen, No. 08899, M. C. Z. 29576, nearly 7 inches long from Vavau, Tonga Islands. Last ray of dorsal and of anal slightly produced as represented in Lacépède's figure. No. A57 about $17\frac{1}{4}$ inches long from Fakarava, Paumotu Islands. No trace of black at base of soft dorsal.

Thirteen specimens from Caroline Islands, Nos. 09082, seven specimens $1\frac{5}{8}$ to $1\frac{3}{4}$ inches long from Moen, and 08904, M. C. Z. 29490, a specimen $1\frac{7}{8}$ inches long, and 09054, five specimens $1\frac{3}{4}$ to $1\frac{9}{10}$ inches long from Truk.

Pseudupeneus barberinoides (Bleeker).

Upeneus barberinoides Bleeker, Nat. Tijds. Ned. Ind., 1852, **3**, p. 263.
Upeneus trifasciatus Günther, Fische der Südsee, 1874, **2**, p. 59, taf. 44, fig. C. (In part.)

No. 05853, M. C. Z. 29788, five specimens 3 to $3\frac{5}{8}$ inches long from Vavau, Tonga Islands.

Mulloides flavolineatus (Lacépède).

Day, Fishes of India, 1875, p. 122, pl. 30, fig. 6. Günther, Fische der Südsee, 1874, **2**, p. 56. *Mullus flavolineatus* Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 406.

Three specimens (very bad condition) $5\frac{1}{2}$ to $6\frac{1}{2}$ inches long, and No. A60, $10\frac{1}{4}$ inches long from Makemo, Paumotu Islands. No. 05848, a specimen $5\frac{3}{4}$ inches long from Vavau, Tonga Islands. Nos. 08976 and 08835, 4 and 5 inches long from Funafuti, Ellice Islands. Nos. 05852, $3\frac{3}{4}$ and 05850, M. C. Z. 29528, three specimens each 4 inches long from Bora Bora, Society Islands. No. 09018, $3\frac{3}{4}$ inches long from Guam.

These specimens have shorter and more abruptly arched snout than *M. samoensis*, the barbels are longer, reaching considerably beyond the preopercle, while in *M. samoensis* they scarcely reach the preopercle; the spinous dorsal (in young examples) when depressed reaches nearer the soft dorsal than in *M. samoensis*, but this does not hold good in the larger examples.

Mulloides samoensis Günther.

Fische der Südsee, 1874, **3**, p. 57, taf. 43, fig. B. Jordan & Evermann, Bull. U. S. Fish Comm. 1905, **23**, pt. 1, p. 253, fig. 105.

Four specimens, Nos. 08974, 08975, 08967, 08969, 4 to 5 inches long from Funafuti, Ellice Islands. Two specimens, Nos. 08897, M. C. Z. 29575, $6\frac{5}{8}$ inches long, and 08898, M. C. Z. 29575, $7\frac{3}{4}$ inches long from Vavau, Tonga Islands. Four specimens from Paumotu Islands, 2 of them, Nos. A72 and 05851, 8 and $3\frac{7}{8}$ long from Makemo; No. A53, $7\frac{7}{8}$ inches long from Fakarava, and No. 05849, $5\frac{1}{4}$ inches long from Rangiroa. Two specimens, No. 09018, M. C. Z. 29385, $3\frac{5}{8}$ and 4 inches long from Guam.

While No. A72 has the more slender form of *M. samoensis*, the position of the dorsal and the long barbels is like that of *M. flavolineatus;* the snout is even longer, and less abruptly curved than in the other specimens of *M. samoensis*, and it may be a distinct species; on the other hand all the characters mentioned distinguishing *M. samoensis* and *M. flavolineatus* may be only individual variations of one species.

POMACENTRIDAE.

Pomacentrus pavo (Bloch).

Chaetodon pavo Bloch, Ichth., 1787, **3**, p. 44, tab. 198, fig. 1.

No. 05882, M. C. Z. 29503, two specimens from Makemo, Paumotu Islands. Nos. 08863, $2\frac{1}{5}$ inches long and 08878, 3 inches long from Taritari, Gilbert Islands.

Pomacentrus nigricans (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 281.

Holocentrus nigricans Lacépède, Hist. Nat. Poiss., 1802, **4**, p. 332, 367, 370.

Five specimens, Nos. 05877–05881, 3 to 4 inches long from Makemo, Paumotu Islands. No. 05860, M. C. Z. 29495, 3 inches long from Papeete, Tahiti, Society Islands. No. 08946, M. C. Z. 29496, 3 inches long from Kusaie, Caroline Islands, in a fresh water stream, Feb. 9, 1900.

Pomacentrus lividus (Forster).

Günther, Fische der Südsee, 1881, **7**, p. 228, taf. 124, fig. F. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 283.

Chaetodon lividus Forster, Bloch & Schneider's Syst. Ichth., 1801, p. 235.

Two specimens, Nos. 08949, $3\frac{3}{8}$ inches, and 08951, M. C. Z. 29485, $3\frac{1}{2}$ inches long, from Kusaie, Caroline Islands.

Abudefduf sordidus (Forskål).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 274.

Chaetodon sordidus Forskål, Descript. Anim., 1775, p. 62.

Four specimens from the following localities in the Paumotu Islands: No. 05874, $3\frac{3}{4}$ inches, Makatea; No. A56, $5\frac{3}{4}$ inches, Fakarava; No. 08824, M. C. Z. 29395, 5 inches, Anaa; No. 05875, M. C. Z. 29502, $1\frac{5}{8}$ inches, Rangiroa.

Abudefduf septemfasciatus (Cuvier & Valenciennes).

Glyphisodon septemfasciatus Cuv. & Val., Hist. Nat. Poiss., 1830, **5**, p. 346 (463).

Glyphidodon septemfasciatus Day, Fishes of India, 1877, p. 386, pl. 81, fig. 7. Bleeker, Atlas Ichth., 1877–78, **9**, tab. 409, Pomac. 10, fig. 5.

No. 05873, thirty-two specimens 2 to $5\frac{1}{2}$ inches long from Makatea, Paumotu Islands.

The black spot on the caudal peduncle at the end of dorsal fin is very distinct in all of the specimens up to about 3 inches in length, a little fainter in those $3\frac{1}{4}$ and $3\frac{1}{2}$ inches long, and still fainter in specimens $3\frac{3}{4}$; in specimens $4\frac{3}{4}$ it is barely visible and in a specimen $5\frac{1}{2}$ inches long it does not show.

One specimen, $2\frac{9}{10}$ inches long from Makemo, Paumotu Islands. The band below 3–5 dorsal spine is somewhat more intensified at its upper end than the same band in other specimens of like size from Makatea.

Nine specimens from Makemo, Paumotu Islands, as follows: Nos. A68, $5\frac{1}{8}$ inches; A83, 7 inches; A84, $6\frac{3}{4}$ inches; A90, $6\frac{1}{2}$ inches; A91, $7\frac{3}{4}$ inches; A93, M. C. Z. 29762, $7\frac{1}{2}$ inches; A95, $7\frac{1}{8}$ inches; A97, M. C. Z. 29763, $7\frac{1}{4}$ inches, A102, $6\frac{3}{8}$ inches long, and 29764, $7\frac{1}{4}$ inches long from Tahaa, Society Islands. No. A167, 6 inches long from Taritari, Gilbert Islands. All of the Makemo and other A numbers have a very pale blue wash over the dusky margins of soft dorsal, anal, and caudal which does not quite reach edge of fins.

Abudefduf saxatilis (Linné).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 285.
Chaetodon saxatilis Linné, Syst. Nat. ed. 10, 1758, p. 276.
Glyphidodon saxatilis Günther, Fische der Südsee, 1881, **7**, p. 229, taf. 126, fig. A

Seven specimens, each $\frac{5}{8}$ inches long, from Lagoon at Fakarava, Paumotu Islands. These specimens are too small for positive identification, but they agree very closely with the descriptions of this species. The ground color of the body was probably light bluish; there are 4 cross bars; no pectoral spot and no black stripe on lobes of caudal. Six specimens, M. C. Z. 29518, $\frac{43}{100}$ to $\frac{5}{8}$ inches long from Makemo, Paumotu Islands.

Muzzel and base of caudal are light yellow.

Abudefduf glaucus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 286.
Glyphisodon glaucus Cuv. & Val., Hist. Nat. Poiss., 1830, **5**, p. 355 (475).

Seventy-eight specimens from the following localities in the Paumotu Islands: Nos. 05821, 25 specimens $1\frac{3}{8}$ to $2\frac{7}{8}$ inches long, and 05891, M. C. Z. 29445, two specimens 1 and $1\frac{3}{8}$ inches long from Makatea; No. 05844, fifty specimens $1\frac{43}{100}$ to $3\frac{5}{8}$ inches long from Makemo; No. 05883, $2\frac{3}{8}$ inches long from Fakarava.

Abudefduf zonatus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 286.
Glyphisodon zonatus Cuv. & Val., Hist. Nat. Poiss., 1830, **5**, p. 361 (483).

One specimen, No. 08926, $3\frac{1}{2}$ inches long from Jaluit, Marshall Islands.

Abudefduf antjerius (Kuhl & Van Hasselt).

Glyphisodon antjerius Kuhl & Van Hasselt, Cuvier & Valenciennes's, Hist. Nat. Poiss., 1830, 5, p. 360 (481).
Glyphidodon antjerius Day, Fishes of India, 1877, p. 387, pl. 81, figs. 4, 5.

One specimen, No. 08912, $1\frac{5}{8}$ inches long from Arhno Atoll, Marshall Islands. Dorsal XIII, 12; Anal II, 12.

This specimen lacks the median stripe on nape and forehead and the ocelli on base of dorsal. The band from dorsal above eye forward is much narrower than pupil, and is continued backward along base of dorsal in a series of interrupted spots; numerous small grayish spots on scaly base of dorsal; anal uniform in color.

Abudefduf curacao (Bloch).

Chaetodon curacao Bloch, Ichth., 1787, **3**, p. 106 (79), taf. 212, fig. 1.
Glyphisodon trifasciatus Bleeker, Verh. Bat. Genoot., 1846–47, **21**, p. 19.

Eight specimens from Jaluit, Marshall Islands, as follows, Nos. 09087, 5 inches long, 09010, 4 inches long, 08964, M. C. Z. 29564, $4\frac{1}{2}$ inches long, and five specimens, $3\frac{3}{4}$ to $4\frac{1}{4}$ inches long.

Abudefduf sexfasciatus (Lacépède).

Labrus sexfasciatus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 477, pl. 19, fig. 2
Glyphisodon coelestinus Cuvier & Valenciennes, Hist. Nat. Poiss., 1830, **5**, p. 347 (461) pl. 135.

Five specimens (young) $\frac{7}{8}$ to $1\frac{1}{4}$ inches long, and 05859, 7 inches long, from Papeete, Tahiti, Society Islands, M. C. Z. 29511 (1 specimen). Ten specimens, $\frac{4}{5}$ to $1\frac{5}{8}$ inches long from Fakarava, Paumotu Islands, and one specimen, M. C. Z. 29469, 2 inches long from Makemo, Paumotu Islands.

All the small examples have 12 or 13 anal rays, but the large example

(05859) has dorsal XII, 1, 12; anal 10, the single anal spine has the appearance of two spines grown together. It has perhaps been broken and then grown together.

Dascyllus aruanus (Linné).

Günther, Fische der Südsee, 1881, **7**, p. 235, taf. 124, fig. B.
Chaetodon aruanus Linné, Syst. Nat. ed. 10, 1758, p. 275.

No. 08861, M. C. Z. 29489, a specimen $2\frac{1}{8}$ inches long from Jaluit, Marshall Islands. No. 05876, two specimens, $1\frac{1}{4}$ and $2\frac{3}{8}$ inches long from Fakarava, Paumotu Islands. One specimen, $1\frac{1}{2}$ inches long from Papeete, Tahiti, Society Islands.

Dascyllus trimaculatus (Rüppell).

Cuvier & Valenciennes, Hist. Nat. Poiss., 1830, **5**, p. 330 (441). Günther, Fische der Südsee, 1881, **7**, p. 235.
Pomacentrus trimaculatus Rüppell, Atlas, 1828, p. 39, taf. 8, fig. 3.[1]

No. 08859, $4\frac{3}{4}$ inches long from Jaluit, Marshall Islands. No. 09029, M. C. Z. 29397, $1\frac{3}{8}$ inches long from Suva, Fiji Islands.

It is possible that *D. albisella* Gill from Hawaii is the same as this species. The white bar (which is the only character separating the species) in the Hawaiian specimens is quite large in the small examples (1 inch) and becomes gradually smaller in larger examples; in a 2-inch example it extends only half as far down on the body as in the small (1-inch) example; we have no larger specimens of *D. albisella*, but believe that as the fish becomes larger, the spots are smaller, and gradually disappear. In the specimen of *D. trimaculatus* $4\frac{3}{4}$ inches long, the spot has almost entirely disappeared.

Dascyllus pomacentroides, sp. nov.

Plate 5, figure 1.

Type No. 65812 U. S. N. M., (Field No. 08879), $2\frac{1}{2}$ inches long from Taritari, Gilbert Islands.

General form of a Pomacentrus.

[1] The name *Pomacentrus trimaculatus* Cuvier & Valenciennes (Hist. Nat. Poiss., 1830, **5**, p. 320, 441)) is preoccupied by *Pomacentrus trimaculatus* Rüppell (1828). For the fish named *Pomacentrus trimaculatus* by Cuvier and Valenciennes we propose the name *Pomacentrus dorsomaculatus*.

Dorsal XII, $11\frac{1}{2}$; anal II, $11\frac{1}{2}$; scales 3–27–$8\frac{1}{2}$, 14 pores in lateral line on left side and 18 on right; head 3.33; depth 2.13 in length without caudal; eye 2.72 in head; snout 4; outer teeth in both jaws much enlarged and conical; preorbital serrate.

Color, plain brown; all the fins brown except that the anal is dusky anteriorly and the upper and lower margins of caudal much darker than the middle rays.

Chromis caeruleus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 290.
Heliases caeruleus Cuv. & Val., Hist. Nat. Poiss., 1830, **5**, p. 372 (497).

No. 08880, twenty-one specimens, $1\frac{1}{4}$ to $2\frac{5}{8}$ inches long, from Taritari, Gilbert Islands. Some of these specimens appear to have a double row of teeth in the lower jaw in front, having two large prominently projecting teeth on each side of symphysis of lower jaw.

No. 08862, four specimens $2\frac{1}{4}$ to $2\frac{1}{2}$ inches long from Kusaie, Caroline Islands.

Nineteen specimens, M. C. Z. 29534, $1\frac{1}{5}$ to $2\frac{3}{8}$ inches long from Fakarava, Paumotu Islands.

These specimens agree better with Cuvier & Valenciennes's description of *C. lepisurus* than with *C. caeruleus*, but we follow Jordan & Seale, who make *C. lepisurus* a synonym of *C. caeruleus*.

LABRIDAE.

Stethojulis strigiventer (Bennett).

Bleeker, Atlas Ichth., 1862, **1**, p. 131, tab. 43, fig. 1. Günther, Cat., 1862, **4**, p. 140.
Julis strigiventer Bennett, Proc. Zool. Soc. Lond., 1832, p. 184.

One specimen, No. 08954, $3\frac{3}{10}$ inches long from Wotje, Marshall Islands. No. 09096, and nine specimens 08905, M. C. Z. 29477, 1 to 2 inches long from Truk, Caroline Islands; No. 09089, eleven specimens, $1\frac{1}{2}$ to $2\frac{1}{4}$ inches long from Moen, Caroline Islands. No. 05892, M. C. Z. 29476, two specimens, $1\frac{3}{8}$ and 2 inches long from Fakarava, Paumotu Islands.

Each one of No. 08905 has a small black spot on the base of caudal just

above lateral line, and one on the next to last ray in dorsal and in anal. In No. 09089 the same spots are present, except in one example $2\frac{1}{4}$ inches long, which lacks the spot; in No. 08954 the spot is wanting; in No. 05892 all the spots are much larger than in the other examples, the spot on dorsal, in the smaller example, is situated on the base of the 10th ray and the membrane between 9th and 11th ray; on anal it is on base of next to last ray and the membrane in front of it to 9th ray; in the large example dorsal spot extends from 9th ray to last, not including 9th or last ray. These may be different species, but we can find no other tangible differences.

Stethojulis casturi Günther.

Fische der Südsee, 1881, **7**, p. 255, taf. 141, fig. A.
Stethojulis albovittata Bleeker, Atlas Ichth., 1862, **1**, p. 132, tab. 44, fig. 5.

One specimen, No. 08957, 4 inches long from Wotje, Marshall Islands. This specimen agrees with the figure given by Jordan and Seale, and confirms their conclusions in separating it from *S. albovittata* of Bonnaterre.

Stethojulis bandanensis (Bleeker).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 297, pl. 45, fig. 2.
Julis bandanensis Bleeker, Nat. Tijds. Ned. Ind., 1851, **2**, p. 254.

Six specimens from the following localities in the Marshall Islands, Nos. 09036, three specimens $3\frac{1}{4}$ to $3\frac{3}{8}$ inches, and 09079, M. C. Z. 29482, 3 inches, from Arhno Atoll; Nos. 08955, $3\frac{1}{5}$ inches long, and 08956, $3\frac{1}{2}$ inches, Wotje. 08838, M. C. Z. 29462, 3 inches long from Funafuti, Ellice Islands.

Halichoeres trimaculatus (Quoy & Gaimard).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 301.
Julis trimaculata Quoy & Gaimard, Voy. Astrolabe, Zool., 1835, **3**, p. 705, pl. 20, fig. 2.

No. 05894, two specimens, each about $2\frac{3}{4}$ inches long from Makemo, Paumotu Islands, and No. 05893, M. C. Z. 29508, two specimens, each about 2 inches long from Fakarava, Paumotu Islands.

Julis pulcherrima (Günther).

Cat., 1862, **4**, p. 200.

No. A134, 9 inches long from Kambara, Fiji Islands.

Head 3.41 in length of body to base of caudal; depth 3.41; eye 6.1 in head; snout, including upper lip 3.22; ventral 1.35; pectoral 1.49; longest dorsal spine (1st) 1.41; dorsal IX, 12; A. III, 12; scales 6–78–27.

Color in alcohol, head reddish purplish; traces of bands running same as in *J. purpureum* in Jordan & Evermann's Hawaiian Report; these bands have a faint bluish tinge in alcohol; body brownish, darker on back, with small scattered white spots anteriorly, more crowded, larger and bluish white posteriorly, anteriorly no spots on side below pectoral fins, but some immediately under the pectoral, extending from dorsal to anal posteriorly; a dark brown blotch in membrane between first two dorsal spines; a row of spots running from dorsal forward on nape to above eye, a similar row below this extending from dorsal to middle of eye; the fin yellowish with faint brownish base; a bluish white spot ocellated with brown; at base of each spine and ray, except first spine and ray, a row of similar spots extending from head on each side of nape; fin above these spots thickly spotted with similar but smaller spots for about two-thirds of its height, these spots terminating above abruptly in a row of spots running the entire length of fin; a faint brownish broken narrow band extending from 3d spine to 3d ray; outer margin of fin bluish white with a thread-like inner margin of brown; anal yellowish with a purplish brown base, and a narrow bluish white margin, this margin bordered within by a thread-like purplish brown line; a white spot on second spine just above base, a comparatively large white spot, at base of 3d spine and at base of all the soft rays excepting the next to last ray, a row of bluish white marks and spots beginning on 3d spine just beyond these dots and about midway of height of fin, these markings being irregular semicircular crescents and spots anteriorly, each one beginning on rays and extending on membranes of this character as far as 6th soft ray, thence continuing as irregular spots to end of fin; each one of these marks bordered with faint purplish brown; beyond these, a row of small ocelli with white centers and purplish brown outer rim; between 3d anal spine and 6th soft ray, these ocelli are much smaller than others; two on each membrane; caudal mostly yellow, with purplish brown base; pectoral similar to caudal; ventral slight purplish brown with pale blue outer rays.

Our specimen seems undoubtedly *Julis pulcherrima* of Günther, but it differs from specimens from the Hawaiian Islands identified as *J. pulcherrima*

by Jordan & Evermann, in having a larger eye and longer snout and also in minor color differences. The type of *J. pulcherrima* came from the South Pacific, the type of *J. gaimard* from Hawaiian Islands. There have been many so-called *J. pulcherrima* recorded from Hawaii by various collectors and very few have got any which they identified as *J. gaimard*. The stated differences are so slight that it is doubtful if the Hawaiian *J. gaimard* and *J. pulcherrima* are really distinct.

The color of our specimen agrees fairly well with that of Bleeker's *Coris formosa* in Atlas 1, tab. 19, fig. 3, but he states in his descriptions that *J. formosa* has more scales than *J. gaimardi*; the reverse is the case in the figures.

Thalassoma lunare (Linné).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 305.
Labrus lunaris Linné, Syst. Nat. ed. 10, 1758, p. 283.

One specimen, No. 08960, $6\frac{1}{4}$ inches long from Jaluit, Marshall Islands.

Depth 3.76; head 3.54; eye 5.83; snout 3.04; dorsal VIII, 13; anal II, 11; scales 4–28–9.

Head naked except for a group of 3 small scales on each side of head just above opercles, partly on upper part of opercle.

Color in alcohol, head a dark purplish brown, with lighter bands running obliquely downward and backward across opercles to edge of gill opening; two light bands crossing lower jaw, one just in front of angle of mouth, the other a little further back; body brownish yellow; a large black blotch across caudal peduncle at base of caudal fin; the prolonged rays of the caudal dusky on their basal third; soft and spinous dorsal with a purplish brown base and broad pale margin; anal similar; pectoral purplish brown at base of upper ray and with oblong similarly colored spot on upper half of pectoral but not reaching the tip.

Thalassoma purpureum (Forskål).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 305.
Scarus purpureus Forskål, Descript. Anim., 1775, p. 27.

One specimen, No. A105, $11\frac{1}{2}$ inches long from Whitsunday Island, Pinaki, Paumotu Islands.

Cheilinus digrammus (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 309.
Labrus diagrammus Lacépède, Hist. Nat. Poiss., 1802, **3**, p. 448, 517, 518, pl. 1, fig. 2.
Cheilinus radiatus Bleeker, Atlas Ichth., 1862, **1**, p. 64, 68, tab. 26, fig. 1.

No. A171, a specimen $6\frac{3}{4}$ inches long from Taritari, Gilbert Islands. No. 08952, M. C. Z. 29515, a specimen 5 inches long from Kusaie, Caroline Islands.

Cheilinus undulatus Rüppell.

Neue Wirb. Fische, 1835, p. 20, taf. 6, fig. 2. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 309.

No. 08953, M. C. Z. 29380, $4\frac{1}{4}$ inches long, from Kusaie, Caroline Islands. No. A163, 10 inches long from Taritari, Gilbert Islands. No. A16, 18 inches long from Rangiroa, Paumotu Islands. No. 08872, $6\frac{4}{5}$ inches long from Suva, Fiji Islands.

No. 08872, M. C. Z. 29569, is in very bad condition and the identification is not certain.

The small example, No. 08953, from Kusaie is similar in color, general shape, and measurements to the fish figured by Günther in Südsee, pl. 133, fig. B, except that it has 10 spines. Ours gives the following counts; dorsal X, 9; anal III, $8\frac{1}{2}$; scales 3–22–6.

In No. A163 the color is exactly like that in No. A16, except that it lacks the vermiculations of No. A16 at the axil and base of pectoral. It has dorsal IX, 10; anal III, $8\frac{1}{2}$; scales 3–22–6; head 2.8 to base of caudal; depth 2.7; orbit 7; snout 2.3.

No. A16 gives the following measurements: head 2.8 to base of caudal; depth 2.75; orbit 8 in head; snout 2.3; dorsal X, $10\frac{1}{2}$; anal III, $8\frac{1}{2}$; scales 3–22–6; ventrals not reaching anal; maxillary not reaching orbit; the posterior edge of gape not reaching orbit by a distance equal to nearly the width of orbit; longest dorsal rays, when depressed, reaching slightly beyond origin of upper caudal rays, anal rays about equal in extent to dorsal rays; caudal rounded.

In alcohol there are narrow wavy pale bars and reticulations on the caudal, the edge of fin with broad pale margin; soft dorsal and anal similarly colored, but lacking the pale margins; spinous dorsal similarly colored, but the bars are narrower, and more numerous; 2 short irregular narrow broken purplish brown

bars from the eye backward; rest of head covered with narrow pale vermiculations and streaks.

Inasmuch as our two large specimens have 9 and 10 spines respectively and they do not otherwise differ, the genus Thalliurus based on 10 spines alone is therefore not tenable. Günther's figure of *C. chlorurus* is not the *C. chlorurus* figured by either Bloch or Bleeker, and differs in coloration and in having a rounded caudal.

Cymolutes praetextatus (Quoy & Gaimard).

Day, Fishes of India, 1877, p. 409, pl. 90, fig. 1.
Julis praetextatus Quoy & Gaimard, Voy. Astrolabe. Zool., 1835, **3**, p. 712, pl. 15, fig. 4.

One specimen, No. 05897, 3 inches long from Namuka, Tonga Islands.

Dorsal IX, 13; anal III, 12; scales 75 in lateral line.

This specimen agrees exactly in fin formation with Quoy & Gaimard's description. The original color is now but faintly indicated, but what can be seen agrees with the figure given by Quoy & Gaimard, excepting that our specimen has a small black spot on upper edge of caudal peduncle at base of caudal fin. This spot is stated by Jordan & Evermann to be present in some specimens of *C. leclusii* from Hawaii. Our specimen also agrees fairly well with *C. praetextatus* given by Day. There is no indication in our specimen of the line under the eye and the broad shoulder band, as shown in Bleeker's figure in Atlas Ichth., 1, pl. 31, fig. 1.

SCARIDAE.

Scarichthys caeruleopunctatus (Rüppell).

Günther, Fische der Südsee, 1909, **8**, p. 300.
Scarus (Calliodon) coeruleopunctatus Rüppell, Neue Wirbc. Fische, 1835, p. 24, taf. 7, fig. 3.

Ten specimens from Tonga Islands at Vavau, as follows:— Nos. 05896, eight specimens, $2\frac{5}{8}$ to $5\frac{3}{4}$ inches long; 05895, M. C. Z. 29381, $5\frac{3}{4}$ inches long, and A130, M. C. Z. 29383, $5\frac{7}{8}$ inches long.

Scarus brunneus Jenkins.

Bull. U. S. Fish Comm., 1900, **19**, p. 59, fig. 16.

Nos. A133, M. C. Z. 29770, $8\frac{1}{5}$ inches, and A135, $8\frac{1}{2}$ inches long from Kambara, Fiji Islands. No. A192 $6\frac{1}{4}$ inches long from Jaluit, Marshall Islands.

No. A192 has one tooth on one side and two on other side of upper jaw; No. A133 has one tooth on right side and none on left side; No. A135 has one tooth on right side and one on left side.

We have compared our specimens with specimens of *S. brunneus*, *S. bataviensis*, *S. erythrodon*, and the type of *S. erythacus* and find that they differ in no way from *S. brunneus* except in a naturally larger eye in our specimens, which are smaller than those we had of *S. brunneus*.

Scarus pulchellus Rüppell.

Neue Wirb. Fische, 1835, p. 25, taf. 8, fig. 3.

Pseudoscarus pulchellus Bleeker, Atlas Ichth., 1862, **1**, p. 20, 34, tab. 10, fig. 3. Günther, Cat., 1862, **4**, p. 219.

No. A40, 14 inches long from Fakarava, Paumotu Islands.

Head 3.4 in length; eye 6.71 in head; snout 2.09; pectoral 1.3; dorsal IX, 10; anal III, 9.

General color in alcohol greenish gray, darker on the back; pectorals translucent yellowish; dorsal and anal with a narrow dark margin, that of the dorsal being darkest on spinous portion of fin; caudal with yellow membranes and greenish yellow rays and paler margin, the somewhat produced lobes a little darker than rest of fin.

Scales $2\frac{1}{2}$–24–6; interlobular margin somewhat rounded; 4 scales before the dorsal; 3 rows on cheek; no teeth at corner of mouth; teeth white; lips cover more than half the jaws.

This specimen agrees very well with *S. pulchellus* except the color, and this we cannot make out.

Scarus bataviensis Bleeker.

Nat. Tijds. Ned. Ind., 1857, **13**, p. 342.

Callyodon bataviensis Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 323, fig. 61.

Pseudoscarus bataviensis Bleeker, Atlas Ichth., 1862, **1**, tab. 12, fig. 3, p. 22, 48. Günther, Fische der Südsee, 1909, **8**, p. 317.

Nos. A189, M. C. Z. 29777, and A190 from Jaluit, Marshall Islands.

The teeth in No. A189 are $\frac{2}{1}$ on right side and $\frac{1}{1}$ on left; in No. A190 they are $\frac{1}{1}$ on right and $\frac{2}{1}$ on left.

Regarding the color of these specimens it is like that described by Jordan & Seale, rather than that of Bleeker.

EPHIPPIDAE.

Platax orbicularis (Forskål).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 335.
Chaetodon orbicularis Forskål, Descript. Anim., 1775, p. 59.

One specimen, No. 05890, $1\frac{5}{8}$ inches long from Bora Bora, Society Islands.

CHAETODONTIDAE.

Forcipiger longirostris (Broussonet).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 363, pl. 46.
Chaetodon longirostris Broussonet, Ichth. sist. Piscium, 1782, p. 23, pl. 7.

Plate 5, figure 2.

One specimen $\frac{2}{3}$ inch long, taken at the surface off Fakarava, Paumotu Islands.

This is probably the Tholichthys stage of *F. longirostris* as shown by the great development of the armature on the head.

Megaprotodon trifascialis (Quoy & Gaimard).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 336, pl. 50, fig. 1
Chaetodon trifascialis Quoy & Gaimard, Voy. Uranie. Zool., 1825, p. 379, pl. 62, fig. 5.

No. 05885, a specimen $1\frac{23}{50}$ inches long from Fakarava, Paumotu Islands.

Chaetodon setifer Bloch.

Ichth., 1788, **6**, pl. 426, fig. 1. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 364, pl. 47. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 338.

The collection contains the following specimens from Taritari, Gilbert Islands: Nos. A164, $6\frac{3}{4}$ inches; A162, M. C. Z. 29746, $4\frac{7}{8}$ inches; A174, M. C. Z. 29747, $5\frac{3}{4}$ inches. From Makemo, Paumotu Islands, Nos. A76, $5\frac{1}{4}$ inches; A79, M. C. Z. 29744, $7\frac{3}{4}$ inches; A85, $7\frac{3}{4}$ inches; A101, 7 inches and A104, M. C. Z. 29745, 7 inches. From Kusaie, Caroline Islands, No. 08808, $2\frac{1}{2}$ inches long.

Chaetodon ulietensis Cuvier & Valenciennes.

Hist. Nat. Poiss., 1831, **7**, p. 30 (39). Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 310.

Nos. A82, A88, A80 and 05889, four specimens 5 to $5\frac{1}{8}$ inches long from Makemo, Paumotu Islands, and 05888, two specimens, each $5\frac{5}{8}$ inches long from Rangiroa, Paumotu Islands.

This species is closely related to *C. falcula* of Bloch, from which according to Jordan & Seale "it is well distinguished." The figures of *C. falcula* of Bloch, Bleeker, and Day, have a somewhat different color pattern than that of *C. ulietensis*.

Chaetodon lunula (Lacépède).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 366, pl. 54, fig. 160.
Pomacentrus lunula Lac., Hist. Nat. Poiss., 1802, **4**, p. 507, 510, 513.

Nos. A86, M. C. Z. 29750, $6\frac{1}{4}$ inches, and A89, $6\frac{1}{8}$ inches long, from Makemo, Paumotu Islands. Four specimens, Nos. 09070, M. C. Z. 29501, $\frac{3}{4}$ to $\frac{7}{8}$ inches long, and 09068, $\frac{5}{8}$ inches long from Arhno, and 09077, $\frac{7}{8}$ inches long from Wotje, both in Marshall Islands.

Chaetodon kleinii Bloch.

Ichth., 1787, **4**, p. 7, tab. 218, fig. 2, after Klein.
Tetragonoptrus (Lepidochaetodon) kleini Bleeker, Atlas Ichth., 1877–78, **9**, p. 45, tab. 373, Chaet. 11, fig. 3.

Nos. 08858, four specimens, $3\frac{1}{2}$ to 4 inches long, and 08963, M. C. Z. 29798, $3\frac{3}{4}$ inches; 08962, M. C. Z. 29798, 3 inches; 08965, $4\frac{1}{4}$ inches, from Jaluit, Marshall Islands.

Chaetodon trifasciatus Mungo Park.

Trans. Linn. Soc., 1797, **3**, p. 34. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 372, pl. 52. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 344.

No. 08864, a specimen $3\frac{3}{4}$ inches long from Suva, Fiji Islands.

ZANCLIDAE.

Zanclus canescens (Linné).

Bleeker, Atlas Ichth. 1877–78, **9**, p. 77–78, tab. 366, Chaet., tab. 4, fig. 3. Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 382, pl. 57. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 350.

Chaetodon canescens Linné, Syst. Nat. ed. 10, 1758, p. 272.

No. A175, 6 inches long from Jaluit, Marshall Islands.

No. 08840, M. C. Z. 29790, $2\frac{1}{2}$ inches long from Funafuti, Ellice Islands.

TEUTHIDIDAE.

Teuthis nigricans (Linné).

Chaetodon nigricans Linné, Syst. Nat. ed. 10, 1758, p. 274.

Hepatus nigricans Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 351

No. 08873, a specimen $5\frac{1}{4}$ inches long from Suva, Fiji Islands.

Teuthis elongatus (Lacépède).

?Chaetodon elongatus Lacépède, Hist. Nat. Poiss., 1802, **4**, p. 471, fig. 2.

Acanthurus nigros Günther, Cat., 1861, **3**, p. 332. Fische der Südsee, 1875, **4**, p. 110.

Two specimens from Truk, Caroline Islands, Nos. 09059, $1\frac{1}{2}$ inches long, and 09052, M. C. Z. 29582, $1\frac{23}{50}$ inches long. The last has the following measurements, dorsal IX, $27\frac{1}{2}$; anal III, $25\frac{1}{2}$; scales minute; 11 lobate teeth in each jaw; the ridges of the larval form are indicated on the cheek and on the throat. General color light purplish brown, a broad silvery area as wide as snout extending from belly to a little above pectoral; dorsal, ventral, and anal dusky; pectoral and caudal pale; trace of a yellowish band across base of caudal. Number 09059 seems to differ from the above only in the fin rays which are: dorsal IX, 26; anal III, 24.

Because of the small size of these specimens it is impossible to identify them, with certainty, but they agree more nearly with *Acanthurus nigros* Günther especially in the number of teeth and the fin formulae than with any other described species.

Teuthis triostegus (Linné).

Chaetodon triostegus Linné, Syst. Nat. ed. 10, 1758, p. 274.
Acanthurus triostegus Günther, Cat., 1861, **3**, p. 327. Day, Fishes of India, 1876, p. 204, pl. 48, fig. 2.
Hepatus triostegus Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 354.

Nos. 05872, $1\frac{1}{4}$ inches long from Fakarava, and 05924, M. C. Z. 29480, three specimens, $1\frac{5}{8}$ to $2\frac{1}{2}$ inches long from Makemo, each in Paumotu Islands. Nos. 08927, $2\frac{1}{4}$ inches long from Jaluit, and 08910, M. C. Z. 29483, $1\frac{3}{8}$ inches long from Arhno Atoll, each in Marshall Islands.

Jordan and Seale say: "this seems like *sandwichensis*, but lacks one cross-band and is very pale; only 4 bands on sides." Regarding *sandvicensis* they say, "This is the most abundant species of the genus about Hawaii, where it replaces the closely allied *H. triostegus*. The differences, although slight, are constant."

We have compared our specimens with a specimen of *sandvicensis* from Hawaii, and find the number of cross bands the same, the only difference being the somewhat darker color of the Hawaiian specimen and the continuation of the shoulder band downward and backward below the upper base of the pectoral, which is well shown in the figure given by Jordan & Evermann (Bull. U. S. Fish. Comm. **23**, pt. 1, fig. 172). In our specimens the band does not extend below the pectoral, which character is well shown in Day's figure of *T. triostegus*.

Another specimen, No. 09072 (larval form) $1\frac{1}{8}$ inches long from Arhno Atoll, Marshall Islands.

In color this specimen differs but slightly from *Teuthis elegans* Garman, Deep Sea Fishes, p. 70, pl. 50, fig. 2, the only differences being in the faint V-shaped mark on caudal peduncle, fainter dots at the base of the anal, none at base of the dorsal and a much darker end to the caudal. It differs in other respects as follows: the spines at the ends of alternate ridges at the bases of dorsal and anal are arranged in groups of 2–4 instead of 3–6; the second dorsal spine is equal to the distance from the posterior edge of the pupil to the tip of the snout, instead of equal to the eye and snout; and it has no denticles on the anterior edge, but merely presents a rough and irregular surface, where *T. elegans* is said to have about nine denticles, it is distinctly grooved on each side, with the appearance of two close-set spines, the posterior portion of which seems to be finely serrate on the sides; and the margin of the spinous dorsal instead of hav-

ing an even curve with the margin of the soft dorsal from the tip of the second spine, is slightly falcate; a condition due to the second spine exceeding the third in length, it being about .2 longer; the second spine of the anal is similar to the 2nd spine of the dorsal and has 9 or 10 denticles about the middle of its anterior edge; dorsal IX, 23 instead of IX, 22; anal III, 20, instead of III, 21.

Teuthis guttatus (Bloch & Schneider).

Acanthurus guttatus Bloch & Schneider, Syst. Ichth., 1801, p. 215.

Hepatus guttatus Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 392, fig. 170. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 354.

No. A160, 9 inches, and A161, M. C. Z. 29755, $8\frac{1}{2}$ inches long from Taritari, Gilbert Islands, Nos. A47, 7 inches long, and A48, M. C. Z. 29756, $7\frac{1}{2}$ inches long, from Fakarava, Paumotu Islands.

Teuthis mata (Cuvier & Valenciennes).

Acanthurus mata Cuv. & Val., Hist. Nat. Poiss., 1835, **10**, p. 148 (202). Day, Fishes of India, 1876, p. 205, pl. 48, fig. 1.

No. A24, M. C. Z. 29736, $11\frac{5}{8}$ inches long from Rangiroa, Paumotu Islands.

This specimen has the head 4 in length; depth 2.18; eye 4.44 in head; snout 1.87; preorbital 2.30; pectoral 1.74 in depth; dorsal IX, 25; anal III, 23; 9 teeth on each side in upper jaw.

No. A38, a specimen $12\frac{1}{4}$ inches long from Fakarava, Paumotu Islands.

This specimen has the head 3.81 in length; depth 2.25; eye 4.2 in head; snout 1.97; preorbital 2.42; pectoral 1.73 in depth; dorsal IX, 25; anal III, $23\frac{1}{2}$; 10 teeth on each side in upper jaw.

Tail when spread has the inner portion truncate and the outer rays produced, somewhat lunate when not spread; length of the head about equal to its depth in a line through the middle of the eye.

Color dark brown, with numerous narrow, wavy, longitudinal, bluish stripes, these alike on head and body; they meet on the front profile of the head; breast with coarser stripes; pectoral brown, grading into a pale bluish terminal margin, into which the brown of the rays continue; caudal, anal, and dorsal dark brown, dorsal and anal with a darker margin; ventrals brown.

Ctenochaetus striatus (Quoy & Gaimard).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 398, fig. 174. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 354.

Acanthurus striatus Quoy & Gaimard, Voy Uranie. Zool., 1825, p. 373, pl. 63, fig. 3.

No. 05925, two specimens, each $2\frac{1}{8}$ inches long from Papeete, Tahiti, Society Islands.

Zebrasoma rhombeum (Kittlitz).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 355.

Acanthurus rhombeus Kittlitz, Senckenberg Mus., 1834, **1**, p. 196, pl. 13, fig. 16.

Nos. A109, $7\frac{3}{8}$ inches; A113, M. C. Z. 29749, $6\frac{1}{2}$ inches and A114, $6\frac{1}{2}$ inches long from Tahaa, Society Islands.

Jordan & Seale suggest the possibility of the two forms *Z. flavescens* and *Z. rhombeum* being color variations of one diacromatic species.

Zebrasoma veliferum (Bloch).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 396, fig. 173. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 356.

Acanthurus velifer Bloch, Ichth., 1793, **9**, p. 106, taf. 427, fig 1.

Nos. A110, $9\frac{7}{10}$ inches; A111, 9 inches and A112, M. C. Z. 29739, $9\frac{1}{4}$ inches long from Tahaa, Society Islands.

Acanthurus brevirostris (Cuvier & Valenciennes).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, p. 401, fig. 176.

Naseus brevirostris Cuv. & Val., Hist. Nat. Poiss., 1835, **10**, p. 204 (277), pl. 291. Günther, Fische der Südsee, 1875, **4**, p. 121, taf. 79, fig. A, text fig. 5.

No. A18, M. C. Z. 29738, female, $11\frac{3}{4}$ inches long from Rangiroa, Paumotu Islands. This specimen has head 4.36 in length; depth 2.54; eye 4 in head; distance from front of eye to tip of horn 4.51 in length; eye to tip of upper lip, 1.76 in head; dorsal VI, 27; anal II, 29.

No. A15, a female specimen, 12 inches long, from Rangiroa, Paumotu Islands. This specimen has head 4.54 in length; depth 2.65; eye 4 in head; distance from front of eye to tip of horn 4.06 in length; eye to tip of upper lip 1.64 in head; dorsal VI, 26; anal II, 28.

No. A23, a male specimen, $12\frac{1}{2}$ inches long, from Rangiroa, Paumotu Islands. This specimen has head 4.6 in length; depth 2.67; eye 4 in head; distance from front of eye to tip of horn 3.2 in length; eye to tip of upper lip 1.6 in head; dorsal VI, 28; anal II, 29.

No. A23 is a male and has the snout much longer than the other specimens, its length measured from underneath is $2\frac{1}{2}$ inches long and just equals length of head; the two spines on each side of the caudal peduncle are longer than those in the other specimens, and are close together; their distance apart being less than their height; they are broad, sharp and hooked forward, the posterior one the larger; its height measured on the anterior edge is slightly less than its base; soft dorsal and anal, when depressed, reach the bases of upper and lower caudal rays respectively; caudal truncate.

Ground color, a dark brown on back, graduated to a lighter brown on side and belly; horn marked by narrow longitudinal dusky stripes; cheeks, preorbital, and preopercle covered with small round dark spots; opercle with round dark spots on its upper part, becoming oblong and line-like on lower portion; opercular membrane or flap creamy white; back thickly covered with very small round dusky spots, becoming slightly vertical, oblong in the region of lateral line, and increasing in length on the sides, anteriorly forming linear oblong spots, and on the middle of the body narrow vertical bands; just anterior to caudal spines the spots are round; these markings reach a horizontal line extending from the lower base of the pectoral posteriorly, to about the beginning of the posterior 4th of the base of the soft anal; base of caudal spotted; dorsal and anal plain light brown, the membrane of spinous portion shows traces of a narrow black margin; pectoral light brown, with indication of a lighter margin; caudal greenish yellow, with a dark grayish brown terminal margin; breast, throat, and abdominal region, plain light brown, showing traces of a few very small dusky darker spots just below pectoral.

Nos. A15 and A18, both females. The horn of A15, measured from below, is 1.56 inches long and is 1.5 in head; the horn of A18 is 1.37 inches long and is 1.71 in head. The spines on caudal peduncle of A15 are smaller and farther apart than in A23; their distance apart being much greater than their height or the length of their base; the spines are rounded and not triangular as in A23, and about half as high as length of base; slightly inclined forward, but not

hooked. The spines in A18 are the same as in A15, but their bases are a little closer together, the distance between them being about equal to base of 1st spine. The horn of A15 is much more slender than that in A18; caudal slightly emarginate.

These specimens have been badly preserved and the original color cannot be made out, but they are now brown, showing no traces of spots or lines; except on base of caudal of A15; there are traces of longitudinal stripes on the horns; opercular flap yellow; fins similar in color to A23.

While the horns of these specimens are longer than the dimensions given in current descriptions they, as well as the descriptions, show a wide variation in that character; and since they agree so well in other respects, and inasmuch as this variation seems dependent upon age, size, and sex, we believe them to be *A. brevirostris.*

Acanthurus vlamingi (Cuvier & Valenciennes).

Naseus vlamingi Cuv. & Val., Hist. Nat. Poiss., 1835, **10**, p. 216 (293).
Naseus vlamingii Günther, Fische der Südsee, 1875, **4**, p. 123, taf. 81.

No. A21, 15 inches long from Rangiroa, Paumotu Islands.

SIGANIDAE.

Siganus fuscescens (Houttuyn).

Evermann & Seale, Bull. U. S. Bur. Fish., 1907, **26**, p. 98.
Centrogaster fuscescens Houttuyn, Verh. Hall. Maat. Weet. Haarlan, 1782, **20**, p. 333.

Nos. 08811, $5\frac{1}{2}$ inches; 08812, $5\frac{3}{4}$ inches, and 08813, M. C. Z. 29783, $5\frac{1}{4}$ inches long from Kusaie, Caroline Islands.

These specimens are in very poor condition.

Siganus punctatus (Bloch & Schneider).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 360.
Amphacanthus punctatus Bloch & Schneider, Syst. Ichth., 1801, p. 210.

No. A65, a specimen $13\frac{1}{2}$ inches long from Makemo, Paumotu Islands.

This specimen has head 4.66 in length; depth 2.45; eye 4 in head; snout 2.4; pectoral 1.12; dorsal XII, 10; anal VII, 9.

No. A182, M. C. Z. 29753, a specimen $12\frac{1}{4}$ inches long from Arhno, Marshall Islands.

This specimen has head 4.62 in length; depth 2.5; eye 4.07; snout 2.4; pectoral 1.23; dorsal XIII, 10; anal VII, 10.

In each the caudal is deeply lunate when spread, otherwise it appears deeply forked.

Color of No. A65, head and body rather dark brown, showing faint traces of the spotted or reticulated effect, like that in Günther's figure of *Teuthis rostrata* (Fische der Südsee, taf. 60); pectorals yellow; ventrals gray, barred with brown; spinous dorsal gray, mottled with brown, spinous anal same; soft dorsal and anal have a translucent membrane, and rays barred with brown; caudal brown, grading into a mottled greenish gray terminal margin. Other specimens are colored in the same way, but show no mottling on caudal margin.

We follow Jordan & Seale in identifying this fish as *S. punctatus*, which from descriptions seems to differ from *S. rostratus* in no way except in depth of body.

Siganus rostratus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 360.
Amphacanthus rostratus Cuv. & Val., Hist. Nat. Poiss., 1835, **10**, p. 116 (158).
Teuthis rostrata Günther, Fische der Südsee, 1874, **3**, p. 89, taf. 60.

One specimen, No. 09032, 2 inches long from Suva, Fiji Islands.

SCORPAENIDAE.

Sebastopsis scabra (Ramsay & Ogilby).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 374, fig. 71.
Sebastes scabra Ramsay & Ogilby, Proc. Linn. Soc. N. S. Wales, 1885, **10**, p. 577.

No. 05935, a specimen $1\frac{3}{4}$ inches long from Bora Bora, Society Islands.

No. 08943, a specimen, M. C. Z. 29468, $2\frac{1}{2}$ inches long from Kusaie, Caroline Islands.

Scorpaenopsis laotale (Jordan & Seale).

Sebastapistes laotale Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 376, fig. 72.

One specimen, No. 05918, $1\frac{1}{5}$ inches long from Makemo, Paumotu Islands.

Although Jordan & Seale include this species in Sebastapistes, they state that it has no palatine teeth. The presence of palatine teeth is one of the generic characteristics of Sebastapistes. Jordan & Seale make the *Scorpaena tristis* of Günther's Südsee a synonym of *Sebastapistes laotale* notwithstanding that Günther says it has palatine teeth. We therefore transfer it to Scorpaenopsis.

Sebastapistes galactacme Jenkins.

Bull. U. S. Fish. Comm., 1904, **22**, p. 496, fig. 40. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 459, fig. 201. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 376, name only.

One specimen (poor condition), No. 05937, $1\frac{3}{4}$ inches long from Suva, Fiji Islands.

The specimen has no supraorbital cirrhus, but one of the two cotypes of Jenkins had none, while the other had a conspicuous one. In other respects it agrees very well with the description given by Jenkins.

Sebastapistes tristis (Klunzinger).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 377.

Scorpaena tristis Klunzinger, Synopsis Fische Rothen Meeres, 1870, p. 802.

No. 05936, a specimen $2\frac{3}{8}$ inches long from Bora Bora, Society Islands.

Pterois volitans (Linné).

Cuvier & Valenciennes, Hist. Nat. Poiss., 1829, **4**, p. 258 (352), pl. 88. Günther, Fische der Südsee, 1874, **3**, p. 81.

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 379.

Gasterosteus volitans Linné, Syst. Nat. Ed. 10, 1758, p. 296.

One specimen 11 inches long from Jaluit, Marshall Islands.

Pterois radiata Cuvier & Valenciennes.

Hist. Nat. Poiss., 1829, **4**, p. 275 (369). Günther, Fische der Südsee, 1874, **3**, p. 81, taf. 56, fig. A.

One specimen No. 05927, 4 inches long from Fakarava, Paumotu Islands.

Pterois antennata (Bloch).

Günther, Cat., 1860, **2**, p. 124.

Scorpaena antennata Bloch, Ausl. Fische, 1788, **6**, p. 16, taf. 185.

Two specimens, No. 05931, $2\frac{1}{2}$ and $3\frac{3}{4}$ inches long from Makatea, Paumotu Islands. M. C. Z. 29519 (1 specimen).

Synanceja verrucosa Bloch & Schneider.

Syst. Ichth., 1801, p. 195, tab. 45. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 379.

Two specimens, No. A194, M. C. Z. 29754, 9 and 9½ inches, respectively, from Jaluit, Marshall Islands.

CARACANTHIDAE.

Caracanthus maculatus (Gray).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 453, fig. 198.
Micropus maculatus Gray, Zool. Misc., 1831, p. 20.

No. 05934, a specimen 1½ inches long from Rangiroa, Paumotu Islands.

Amphiprionichthys unipinna (Gray).

Micropus unipinna Gray, Zool. Misc., 1831, p. 20.
Caracanthus unipinna, Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 454.

No. 05932, four specimens, ⅞ to 1⅛ inches long, from Makemo, Paumotu Islands. M. C. Z. 29399 (2 specimens).

GOBIIDAE.

Ophiocara porocephala (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 384; 1908, **27**, p. 274.
Eleotris porocephala Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 178.
Eleotris ophicephalus Kuhl & Van Hasselt, Cuv. & Val's. Hist. Nat. Poiss., 1837, **12**, p. 180 (239).
Eleotris ophiocephalus Günther, Fische der Südsee, 1877, **6**, p. 185, taf. 112, fig. A.

One specimen, No. 08801, 5⅞ inches long from Kusaie, Caroline Islands.

Head 3 in length; eye 6 in head; snout 3.2; dorsal VI–I, 9; anal I, 8; scales 34, 22 in front of dorsal.

One specimen, No. 08988, M. C. Z. 29392, 3⅝ inches long from Kusaie, Caroline Islands.

Head 2.9 in length; eye 4.5 in head; snout 3.33; dorsal VI–I, 9; anal I, 8; scales 33.

Two specimens, 10¼ and 11½ inches long from Kusaie, Caroline Islands. The smaller specimen has dorsal VI, 1, 8½; anal, I, 7½; scales from origin of

dorsal to anal 11, from upper end of gill opening to last large scale 35, from front of dorsal to line on middle of eye 15; maxillary reaches line on middle of eye. The larger specimen agrees in all the above counts and is similar in color in all respects, both agreeing with Günther's figure and description, but not with that of Day; it is more like Day's figure of *O. porocephalus* in coloration and size of mouth; Günther includes *O. porocephalus* of Cuv. & Val. in his synonymy of *O. ophiocephalus* in which he is probably correct. M. C. Z. 29784, Kusaie, Caroline Islands (1 specimen).

Asterropterix semipunctatus Rüppell.

Asterropterix semipunctatus Rüppell, Atlas, 1828, p. 139, taf. 34, fig. 4. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 385, pl. 36, fig. 1.

Elcotris semipunctata Günther, Fische der Südsee, 1877, **6**, p. 187, taf. 111, fig. D.

One specimen, No. 05920, $1\frac{3}{8}$ inches long from Fakarava, Paumotu Islands.

Eviota zonura Jordan & Seale.

Bull. U. S. Bur. Fish., 1906, **25**, p. 386, fig. 75.

The collection contains the following from the Paumotu Islands: two specimens, M. C. Z. 29379, each about $\frac{4}{5}$ inches long from Fakarava; two specimens, $\frac{23}{50}$ and $\frac{5}{8}$ inch long from Rangiroa and one specimen, $\frac{23}{50}$ inch long from Makemo.

Periophthalmus barbarus (Linné).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 393.

Gobius barbarus Linné, Syst. Nat. ed. 12, 1766, p. 450.

Nos. 09098, a specimen $4\frac{1}{2}$ inches long and 09099, $4\frac{1}{8}$ inches long from Moen, Truk Group, Caroline Islands. No. 05910, M. C. Z. 29521, $2\frac{1}{4}$ inches long from Suva, Fiji Islands.

Oplopomus oplopomus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 396.

Gobius oplopomus Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 50 (66). Günther, Fische der Südsee, 1877, **6**, p. 170, taf. 110, fig. B.

One specimen, No. 09060, $2\frac{1}{4}$ inches long, from Moen, Truk Group, Caroline Islands.

D. VI, I, 10; anal I, 10.

This agrees very well with Günther's description and figure of this species. It is, however, a little more slender, and has one more dorsal ray than Günther gives in his description, but the same number as shown in his figure. This species resembles *O. vergens* Jordan & Seale in having a more slender body and distinct lateral spots, but differs from *O. vergens* in having a larger eye; two conspicuous canine teeth on the lower jaw and produced spinous rays in the first dorsal fin.

Ruppellia echinocephalus (Rüppell).

Gobius echinocephalus Rüppell, Atlas, 1828, p. 136. Cuvier & Valenciennes, Hist. Nat. Poiss., 1837, **12**, p. 101 (134). Klunzinger, Fische Rothen Meeres, 1870, p. 475. Günther, Fische der Südsee, 1877, **6**, p. 175, taf. 108, fig. D.

Gobius amicicnsis Cuvier & Valenciennes, Hist. Nat. Poiss., 1837, **12**, p. 102 (133).

Paragobiodon echinocephalus, Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 397.

Twelve specimens, No. 05913, $\frac{5}{8}$ to $1\frac{1}{8}$ inches long from Makemo, Paumotu Islands.

Color in alcohol, body very dark brown; dorsal, pectoral, anal, and caudal almost black; ventrals pale; head in most specimens abruptly lighter brown.

Five specimens, No. 05914, M. C. Z. 29465, $\frac{7}{8}$ to $1\frac{1}{8}$ inches long, from Vavau, Tonga Islands.

The three smallest specimens are similarly colored, but somewhat lighter than those from Makemo. The two largest are uniformly light brown all over.

Two specimens $\frac{5}{8}$ and $\frac{23}{50}$ inches long from Rangiroa, Paumotu Islands.

Body dark brown, head abruptly light brown; dorsal, anal, and caudal almost black, with punctulated lighter margins; pectoral pale with fine punctulations; ventrals pale.

One specimen, No. 05915, $\frac{4}{5}$ inches long from Bora Bora, Society Islands. Similar in color to those from Makemo.

Ruppellia lacunicola, sp. nov.

Plate 6, figure 1.

Type, No. 66006, U. S. N. M., $\frac{7}{8}$ inch long from Lagoon at Fakarava, Paumotu Islands.

Head 3; depth 3.27; eye 4; dorsal VI–10½; anal 10; 22 scales in longitudinal series.

Color in alcohol, uniform dark straw. All the fins except the ventrals brownish black; ventrals very pale reddish brown. This species is close to *P. echinocephalus* from which it differs in coloration, in being less elongate, having smaller canines, coarser and fewer flaps, and practically no hair-like papillae on head.

Zonogobius semidoliatus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 397, fig. 86.
Gobius semidoliatus Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 51.

Two specimens, No. 05921, ¾ and ⅘ inches long from Bora Bora, Society Islands. M. C. Z. 29593 (1 specimen).

Vailima stevensoni Jordan & Seale.

Bull. U. S. Bur. Fish., 1906, **25**, p. 398, fig. 87.

One specimen, 2⅛ inches long from Tipaerui Valley, Papeete, Society Islands.

Gobius ornatus Rüppell.

Atlas, 1828, p. 135. Günther, Fische der Südsee, 1877, **6**, p. 172, taf. 3, fig. A. Day, Fishes of India, 1876, p. 294, pl. 63, fig. 1. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 401, fig. 91.

Nos. 08901, M. C. Z. 29530, five specimens, ⅝ to 1⅜ inches, and 09057, three specimens 1½ to 2⅜ inches long from Moen, Truk Group, Caroline Islands.

No. 08938, M. C. Z. 29491 one specimen, 2¾ inches long from Tonga Islands.

Two specimens, No. 09088, each 1⅛ inches long from Moen, Truk Group, Caroline Islands.

One specimen, No. 09033, M. C. Z. 29493, 1½ inches long from Suva, Fiji Islands.

The two small specimens from Moen resemble in every way the specimens of same size from Suva except in having a longer and slightly more humped snout. The large one differs in the same way, but has in addition a more slender caudal peduncle and the white markings are not definite.

Mapo fuscus (Rüppell).

Jordan & Evermann, Bull. U. S. Fish Comm., 1905, **23**, pt. 1, p. 483, fig. 212. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 402.

Gobius fuscus Rüppell, Atlas, 1828, p. 137.

Gobius albopunctatus Cuvier & Valenciennes, Hist. Nat. Poiss., 1837, **12**, p. 57.

No. 05908, five specimens $1\frac{7}{8}$ to 3 inches long from Rangiroa; one specimen $1\frac{3}{4}$ inches long and Nos. 05919, 05912, $2\frac{1}{2}$ inches and $1\frac{3}{4}$ inches long from Makemo, both places in Paumotu Islands. No. 09051, M. C. Z. 29526, $1\frac{3}{4}$ inches long from Vavau, Tonga Islands. No. 08944, M. C. Z. 29481, 3 inches long from Kusaie, Caroline Islands. Nos. 08939, M. C. Z. 29504, two specimens $1\frac{3}{4}$ and 2 inches long from Tonga Islands and 08913, $1\frac{3}{4}$ inches long from Arhno Atoll, Marshall Islands.

Glossogobius biocellatus (Cuvier & Valenciennes).

Gobius biocellatus Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 57 (74). Day, Fishes of India, 1876, p. 289, pl. 63, fig. 8.

One specimen, 1 inch long from Makemo, Paumotu Islands. This specimen is too small for positive identification, but it is provisionally identified with *G. biocellatus*, since it agrees very well in all the characters given, except in coloration. It has dorsal VI–I, 9; A. I, 9 (Cuv. & Val. give D. VI, I, 10; A. I, 9); scales at least 27; tongue notched; head naked; it agrees perfectly with Day's description of teeth.

Color in alcohol, pale, slight traces of large brownish spots on sides and narrow bar across base of caudal; group of large punctulations anteriorly at base of spinous dorsal, other smaller groups near end of rays indicating possible bands, but the membrane is torn and the spines are separated somewhat. A few punctulations in longitudinal series on the middle of the rays of the soft dorsal.

Awaous genivittatus (Cuvier & Valenciennes).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 492, fig. 218.

Gobius genivittatus Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 64. Günther, Fische der Südsee, 1877, **6**, p. 170, taf. 110, fig. C.

One specimen, No. 08989, $3\frac{1}{2}$ inches long from Kusaie, Caroline Islands.

Amblygobius phalaena (Cuvier & Valenciennes).

Jordan & Richardson, Bull. U. S. Bur. Fish., 1908, **27**, p. 278.

Gobius phalaena Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 70 (92). Günther, Cat., 1861, **3**, p. 67.

One specimen, No. 09096, $1\frac{1}{8}$ inches long from Vavau, Tonga Islands.

Dorsal VI — 15; Anal 15; scales in lateral series 52.

This specimen agrees quite well with the descriptions of this species, differing, however, in the following points: instead of three rows of spots on the sides of the head there is a brownish band bordered by narrow marginal bands of light gray; 18 scales in longitudinal series between the 2nd dorsal and the anal instead of 16.

The specimen has, as mentioned in Günther's description of a young example, a single black spot in the upper part of the base of caudal; the pectoral fins are too badly torn to be certain as to their color pattern.

Amblygobius sphinx (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 406.

Gobius sphinx Cuv. & Val., Hist. Nat. Poiss., 1837, **12**, p. 70 (93). Günther, Cat., 1861, **3**, p. 67.

One specimen, No. 09085, $1\frac{1}{8}$ inches long from Moen, Truk Group, Caroline Islands.

Head 3.22 in length; depth 3.86; eye 3.6 in head; snout 4.5; interorbital 5.62; maxillary 2.57; longest ventral ray 1.63; pectoral ray 1.12; scales 54, 18 in transverse series; dorsal VI, 15; anal 14.

Color (faded) in spirits, brown, there are about 5 darker brown cross bars; back with pale mottlings; a series of cross streaks from lateral line to belly, one in front of pectoral, 4 or 5 behind pectoral; posterior to these from lateral line across ventral region, a series of 4 pairs of light brown narrow bars; first pair near vent, second posterior to origin of anal, third under posterior part of anal, fourth on caudal peduncle; a faint spot on middle of opercle; a small black spot on upper angle of opercle; a dusky bar across posterior margin of gill membrane, also a brown spot on each side of the isthmus (chin) close to the symphysis; numerous small pearly white spots on cheeks and opercles; a dark brown spot on shoulder just back of opercular spot; a small white-edged black

ocellus at base of caudal immediately above lateral line; the indistinct clouded effect on the back corresponds to pairs of bars on the belly; some black on both dorsals, too badly torn to determine pattern; ventrals and anals slightly dusky.

Gobiodon histrio (Kuhl & Van Hasselt).

Günther, Cat., 1861, **3**, p. 88.

Gobius histrio Kuhl & Van Hasselt, Cuvier & Valenciennes's, Hist. Nat. Poiss., 1837, **12**, p. 100, (132), pl. 347, lower fig.

Eight specimens, part of No. 05918, 1 to $1\frac{1}{2}$ inches long from Fakarava, Paumotu Islands, M. C. Z. 29524 (4 specimens).

Description of largest specimen: Dorsal VI, 11; anal 10; head 3.36 in body; depth 2.61; depth of head in head .9; eye 4.75; maxillary reaching very slightly, if any, beyond a line from front margin of orbit, not from the pupil; body strongly compressed; profile rounded.

Colors, dark brown with lighter head and breast somewhat darker fins.

These specimens have the general shape of *G. atrangulatus* but with a smaller mouth; they also have the general shape of Günther's figure in Fische der Südsee of *G. ceramensis*, but in our specimens the dorsals are united. Structurally they agree better with the description in Cuvier & Valenciennes of *G. histrio* than with any other described species, except that there are no tubercles on the head; since, however, these specimens do not now agree in color, we provisionally refer them to *G. histrio*.

Gobiodon atrangulatus Garman.

Bull. Mus. Comp. Zoöl., 1903, **39**, p. 234, pl. 2, fig. 2.

Five specimens, No. 05918 — part, $\frac{2}{3}$ to $1\frac{1}{8}$ inches long from Fakarava, Paumotu Islands. M. C. Z. 29378 (2 specimens).

Description of largest specimens, Dorsal VI, 11; anal 10; head 3.5 in body; depth 2.72; depth of head in head .97; eye 3.5; maxillary extending to below middle of the eye; mouth larger than in *G. rivulatus*. Color, the two largest specimens similar in color being light brown with bluish tint in reflected light and thickly sprinkled with fine darker punctulations; vertical fins somewhat dusky; near the tip of each dorsal spine is a small black spot indicating that it

may have had a narrow submarginal border. The three smallest specimens are uniformly plain straw color.

Gobiodon rivulatus (Rüppell).

Günther, Cat., 1861, **3**, p. 87. Fische der Südsee, 1877, **6**, p. 180, taf. 109, fig. F.
Gobius rivulatus Rüppell, Atlas, 1828, p. 136. Neue Wirb. Fische, 1835, p. 138.

Two specimens, No. 05916, $\frac{7}{8}$ to $1\frac{1}{4}$ inches long from Fakarava, Paumotu Islands. M. C. Z. 29592 (1 specimen).

Measurements of larger examples; Depth of head in length of head 1.41; head 2 in body; depth 1.92; eye 6.25 in head; maxillary reaches to below anterior edge of pupil; dorsal VI, 11; anal 9. Color plain light yellowish brown; fins paler.

These specimens agree in form with Günther's figure in Fische der Südsee, taf. 109, fig. F.

Gobiodon citrinus (Rüppell).

Günther, Fische der Südsee, 1877, **6**, p. 181, taf. 109, fig. E.
Gobius citrinus Rüppell, Neue Wirb. Fische, 1835, p. 139, taf. 32, fig. 4.

One specimen, No. 05917, $1\frac{1}{2}$ inches long from Vavau, Tonga Islands.

One specimen, M. C. Z. 29460, No. 08945, $1\frac{3}{4}$ inches long, from Kusaie, Caroline Islands.

Sicyopterus taeniurus (Günther).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 410
Sicydium taeniurum Günther, Fische der Südsee, 1877, **6**, p. 183, taf. 112, fig. C.

Four specimens, No. 05902, $2\frac{1}{2}$ to $4\frac{1}{2}$ inches long from Fataua River, Tahiti, Society Islands. M. C. Z. 29472 (2 specimens).

The largest specimen gives the following measurements: Head 4.5 in length; eye 2.25 in interorbital; interorbital 2.5 in head; eye 5.71 in head; dorsal VI, 12, anal 10. Produced dorsal rays reaching a little beyond base of caudal; last anal rays barely reaching base of caudal; middle rays of pectoral 17 mm.; longest dorsal spine 33 mm.; length of head 20 mm.; scales 50. Color: ground color dark brown; caudal peduncle and caudal lighter with darker center, and darker outer margins; dark shade from back of eye towards corner of mouth.

PARAGOBIOIDES, gen. nov.

Type *P. grandoculis*, sp. nov.

Similar to Gobioides but with very large eyes. The ventral fins apparently separate, but it is uncertain if the division is normal.

Paragobioides grandoculis, sp. nov.

Plate 6, figure 2.

Type No. 65975, U. S. N. M., $1\frac{7}{8}$ inches long, Arhno Atoll, Marshall Islands.

Body elongate, slender, with minute scales; dorsal 58, inserted at a distance from tip of snout equal to about $\frac{1}{3}$ base of dorsal, its rays somewhat produced beyond membrane; anal 38, inserted at a distance from tip of lower jaw equal to about $\frac{1}{3}$ base of anal; ventrals I, 5; caudal with middle rays somewhat produced. Mouth somewhat oblique, lower jaw projecting, lip thick and fleshy; teeth in bands in both jaws, the upper with two canine-like teeth anteriorly, one on each side; outer series of lower jaw enlarged, growing progressively shorter posteriorly; apparently fine teeth on vomer and palatines; gill membranes broadly joined to the isthmus; head 7.5 in length to base of caudal; depth 13.23; eye 4.25.

Color pale straw, fins colorless excepting the caudal which is slightly dusky at the tips of rays. Probably a young fish.

CALLIONYMIDAE.

Callionymus cookii GÜNTHER.

Proc. Zool. Soc. Lond., 1871, p. 665. Fische der Südsee, 1877, **6**, p. 192, taf. 113, fig. B.

Two specimens, No. 05939, M. C. Z. 29596 (1 specimen), $1\frac{5}{8}$ and $2\frac{1}{4}$ inches long from Fakarava, Paumotu Islands.

The $2\frac{1}{4}$ inch specimen is apparently a male, the other a female. Dorsal IV, 8; anal 7.

These specimens agree more closely with *Callionymus cookii* than with any other described species. The colors are faded, but in the male there are traces

of cross bars on the body and tail as well as small ocelli; dorsals and pectorals show traces of spots; ventrals plain; anal with dusky punctulations; first dorsal spine not produced, but last rays of second dorsal and middle rays of caudal produced. In the female the colors are similar to the above, but with what appears to have been a white-edged black blotch on spinous dorsal; the rays are now detached and this mark is not definite; second dorsal and caudal not so much produced. Neither specimen shows traces of spots on anal.

BLENNIDAE.

Enneapterygius atriceps (Jenkins).

Tripterygion atriceps Jenkins, Bull. U. S. Fish. Comm., 1903, **22**, p. 505, fig. 46.

One specimen slightly over one inch long from Ponapi, Caroline Islands.

This specimen agrees so closely with the type specimens of *E. atriceps*, with which it has been compared, that we identify it as that species, although it differs somewhat in the vertical fin counts. Head 3.3; eye 3.25; dorsal III–XIII–10; A. I, 17; scales 32 or 33. The coloration is the same as in the type.

Hypleurochilus vaillanti Jordan & Seale.

Bull. U. S. Bur. Fish., 1906, **25**, p. 420.

One specimen, M. C. Z. 29377, $\frac{23}{50}$ inch long from Lagoon at Fakarava, Paumotu Islands.

One specimen, $1\frac{3}{10}$ inches long from Ponapi, Caroline Islands.

An examination of the type, No. 51788, U. S. N. M., from Pago Pago, Samoa, shows that it has the dorsal XII, 18 (not XII, 15, as given in description by Jordan & Seale), and the anal 19 (not 17). Our specimens agree with this, except that there appear to be 20 anal rays in the smaller specimen.

Alticus periophthalmus (Cuvier & Valenciennes).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 422.

Salarias periophthalmus Cuv. & Val., Hist. Nat. Poiss., 1836, **11**, p. 230 (311), pl. 328. Günther, Fische der Südsee, 1877, **6**, p. 207, taf. 114, figs. D, E. Day, Fishes of India, 1876, p. 333, pl. 69, fig. 5.

No. 05906, a specimen $2\frac{3}{8}$ inches long from Makemo, Paumotu Islands.

Alticus caudolineatus Günther.

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 423.
Salarias caudolineatus Günther, Fische der Südsee, 1877, **6**, p. 209, taf. 116, fig. F.

No. 05909, M. C. Z. 29583 (1 specimen), 2 specimens 2 and $1\frac{3}{4}$ inches long (poor condition) from Rangiroa, Paumotu Islands.

Dorsal XII, I, 20; anal 21; simple supraorbital tentacle, and a bifid nasal tentacle. Our specimens do not agree exactly in the above characters with Günther's description.

Salarias lineatus Cuvier & Valenciennes.

Hist. Nat. Poiss., 1836, **11**, p. 232 (314). Day, Fishes of India, 1876, p. 332, pl. 70, fig. 8. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 426.

One specimen, No. 08915, M. C. Z. 29370, $2\frac{3}{4}$ inches long from Arhno Atoll, Marshall Islands.

Head 5 in body; depth 5; eye 3.42 in head; dorsal XII (I), 23; anal 25; no crest.

Moderately slender, head bluntly rounded, profile steep, a short fringed nasal cirrus; a supraocular cirrus is sharply triangular and fringed on both sides.

Color in alcohol: ground color on top of head and back light brownish gray, faintly mottled with darker and lighter on back; about 3 rows of small black longitudinal spots beginning on a line under posterior 4th of dorsal and extending on body to base of caudal; caudal irregularly blotched with dark brown, but with a sharply defined narrow dark brown band running from the middle of the upper margin obliquely downward and backward; longitudinal light streaks on side, making broken lines, these being less broken farther down on the side, showing faintly near base of anal; sides with about 12 pairs of purplish brown cross bars somewhat triangular in shape with a wide angle, apex forward; color most intense on axis of body but continuing faintly toward dorsal and anal; 4 or 5 faint light bars across cheeks; 2 dark bars across base of pectoral; dorsals finely punctate, a brownish margin on soft dorsal anteriorly, a row of very faint dark spots on base of soft dorsal, arranged in pairs posteriorly; anal plain, pale, with a few fine punctulations on the upper margins of membranes and rays anteriorly.

Three other specimens, number 05899, $2\frac{1}{8}$ to $3\frac{1}{4}$ inches long from Fakarava, Paumotu Islands.

One of these specimens, $3\frac{1}{4}$ inches long, has head 4.85 in body; depth 5.23; eye 4 in head; dorsal XII (I), 24; anal 24; crest on head, dorsal higher than the dorsal of another specimen $2\frac{7}{8}$ inches long, which has head 4.59; depth 5.16; eye 3.85; dorsal XIII, 24; anal 24; no crest on head.

Color of specimen $2\frac{7}{8}$ inches long without crest; comparing this specimen with 08915 it is much darker in color being light brown, abdomen abruptly white, same markings on body but not so dusky on tail, and lacking the oblique black bar; throat and chin dusky; spots at base of soft dorsal more distinct, and paired cross bars less distinct; spinous dorsal similar to body; traces of oblique light lines on soft dorsal as in *S. rivulatus*.

The $3\frac{1}{4}$ inch specimen with crest and body more elongate has the color generally darker, body markings less distinct than the specimen, $2\frac{7}{8}$ inches long without crest; light bars on soft dorsal a little more distinct; a narrow dusky margin on soft dorsal, with a narrow border of white; anal plain light brownish with dusky margin, at least in front; caudal same as body with a darker upper and lower margin and central rays, most intense at base, rays tipped with white.

Salarias edentulus (Bloch & Schneider).

Günther, Fische der Südsee, 1877, **6**, p. 206, taf. 117, fig. A. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 429.

Blennius edentulus Bloch & Schneider, Syst. Ichth., 1801, p. 172.

Salarias rivulatus Rüppell, Atlas, 1828, p. 114. Jordan & Seale, loc. cit., p. 429.

Salarias quadricornis Day, Fishes of India, 1876, p. 331, pl. 70, fig. 4.

The collection contains the following female specimens from the Paumotu Islands: Nos. 05903, $3\frac{7}{8}$ inches long from Makemo; 05898, $3\frac{3}{8}$ inches long from Fakarava; 05907, 3 inches and 08936, M. C. Z. 29527, $2\frac{1}{8}$ inches long from Rangiroa.

The last specimen has dorsal XII, 21; anal 23, and agrees in color with current descriptions of the species, except that on the caudal the spots are more or less coalescent, forming 3 wavy, broken cross bars. It differs from the description given by Jordan & Richardson in Fishes from Islands of the Philip-

pine Archipelago (Bull. U. S. Bur. Fish., 27, p. 284), in having one more anal ray.

The following male specimens are in the collection (formerly called *rivulatus*), Nos. 05900, $3\frac{5}{8}$ inches and 05904, three specimens $2\frac{1}{8}$ to $5\frac{1}{8}$ inches from Makemo, Paumotu Islands.

The last three specimens each have dorsal XIII, 20; anal 24. Nos. 05911, M. C. Z. 29516, four specimens 2 to $2\frac{1}{4}$ inches long from Makemo, and 05901, M. C. Z. 29382, $4\frac{2}{3}$ inches long from Rangiroa, Paumotu Islands.

The largest specimen among No. 05904 gives the following: head 4.41 in body; depth 4.07; eye 4.36 in head; longest dorsal spine 1.41; longest ray 1.25; longest anal ray 1.60; dorsal XII, 20; anal 22. Soft dorsal attached to caudal for about $\frac{2}{7}$ of its length; caudal slightly rounded; front of head almost perpendicular; slightly rounded; crest present; supraorbital tentacle bifid; a single row of cardiform teeth in each jaw; no canines present, anterior nostril with short tube having a fringe of cirri on its posterior border.

In spirits this specimen is much lighter than the other specimens though similarly but more faintly marked on body; soft dorsal dusky in front, lighter behind, showing very slight traces of the lighter bars. The fin is also very light colored with a broad dusky margin showing slight traces of oblique bars; anal light colored, also showing slight traces of bars and with narrow dusky margin on membrane; caudal has a broad faintly dusky margin and faint dusky bar about middle.

The differences formerly separating *S. edentulus* and *S. rivulatus* were the presence of an occipital crest in *S. rivulatus*, and differences in coloration. These are, however, merely sexual characters. In the fishes of Samoa Jordan & Seale record seventy-five specimens of *S. rivulatus* and sixty of *S. edentulus* from Apia and Pago Pago. An examination of thirty-seven of these shows that of twenty-four specimens identified as *S. rivulatus* all but one of the mature specimens are males, and this one lacked the crest and had the coloration of the *S. edentulus* form. Of the thirteen specimens identified as *S. edentulus* all were females except one, and this one had a crest and the coloration of the *S. rivulatus* form. All of our specimens show the same differences and leave no doubt but that the two species are identical.

Petroscirtes mitratus Rüppell.

Atlas, 1828, p. 111, taf. 28, fig. 1.

Nos. 08908, M. C. Z. 29522, three specimens each $1\frac{1}{2}$ inches, and 09086, four specimens $1\frac{1}{2}$ to $1\frac{3}{4}$ inches long, from Moen, Truk Group, Caroline Islands.

Petroscirtes quadrimaculatus, sp. nov.

Plate 7, figure 1.

The collection contains two specimens, No. 09069, $1\frac{5}{8}$ and $1\frac{7}{8}$ inches long from Arhno Atoll, Marshall Islands, the larger of which is the type, and one specimen, M. C. Z. 29393, 1.75 inches long from Papeete, Tahiti, Society Islands. The type No. 65980, U. S. N. M., gives the following measurements:

Head 4.25 in body length; depth 6.07; eye 3.33 in head; snout 3.33; head rather sharply conical; posterior nostril with a slightly raised membranous edge, anterior nostril with short tubes; two rows of narrow, close-set, rounded incisors in upper jaw, those of inner row larger, no teeth visible on vomer or palatines; one row of larger incisors in the front of the truncate lower jaw, and a huge backward curved, fang-like canine tooth in the anterior angle of each side of lower jaw, the lower incisors horizontal; caudal truncate; dorsal 41; anal 29.

Color: back, upper side of body and top of head light brown; a series of large quadrate dark brown spots, separated by narrow interspaces, from back of eye to base of caudal, below which an abruptly narrow silvery stripe extending from tip of lower jaw and lower border of eye to base of caudal; the surface below this band plain whitish. The narrow interspaces between the spots on body are made up of pairs of light colored lines diverging at top and extending to base of dorsal, darker between, but not so dark as the quadrate spots, and causing spots to show faintly as if continuous to the dorsal; very narrow light colored bars extending below from the middle, or a little in front of middle, to the anal; the second interspace behind the pectoral continues in this way.

Dorsal and anal are crossed by broad bars, parallel with the rays, corresponding to the quadrate spots in position, the broad bars covering about .8 of width of fin; above these a narrow whitish stripe with a very narrow blackish border, tips of rays white; the borders not showing on anal, but tips of rays also white; pectoral, ventral, and caudal pale.

In the cotype, the ground color similar to type but instead of spots there are about the same number of cross bars on the body and extending across entire side, narrower at base of dorsal, than at base of anal, most distinct in middle line of body, extending across anal and to middle of dorsal; rest of dorsal as in type; anal without light border and other fins as in type. A light spot in center of each of the broad dark bars on body appearing as an intensification of the longitudinal silvery stripe of the type; the narrowing of the bars on back due to the diverging of the pairs of lines that make up the interspaces, and the light bars across the lower part of the body continuous with these interspaces and not as in the type.

In the specimen from Papeete the color on body is similar to the type, except that the light bars across the lower portion are continuous with the interspaces and the bars of both dorsal and anal continue entirely across dorsal and anal with no marginal stripes.

FIERASFERIDAE.

Fierasfer parvipinnis Kaup.

Apodes, 1850, p. 160, pl. 16, fig. 2. Günther, Cat., 1862, **4**, p. 383, after Kaup. Fische der Südsee 1909, **8**, p. 338. Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 528.

Jordanicus parvipinnis Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 435.

No. 05926, a specimen $7\frac{3}{5}$ inches long from Papeete, Tahiti, Society Islands.

ECHENEIDIDAE.

Echeneis naucrates Linné.

Syst. Nat. ed. 10, 1758, p. 261. Day, Fishes of India, 1876, p. 257, pl. 57, fig. 1.

Leptecheneis naucrates Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 411.

Two specimens from Paumotu Islands, one, Nos. A44, M. C. Z. 29725, $13\frac{1}{4}$ inches long from Fakarava and A59, $18\frac{1}{2}$ inches long from Makemo. One specimen, No. A157, 20 inches long from Funafuti, Ellice Islands.

No. A157 has dorsal XXIV, 38; anal 34, color brown, lighter above and below, no trace of a lateral stripe, except on head, where it is very distinct, disappearing on base of pectoral; ends of pectoral rays pale; dorsal and anal uni-

form light brown; tips of dorsal rays dusky; outer rays of caudal not pale; caudal irregular, shallow emarginate.

No. A59 has dorsal XXIV, 33; anal 31, color dark brown on back, a distinct lateral stripe, with a distinct white stripe above and below this stripe; pectoral blue black, lacking white tips; caudal deeply lunate with pale outer rays.

No. A44, dorsal XXIII, 34; anal 32; color, dark brown above, with a darker brown lateral stripe, lighter below, but not so light above as in A59; ends of lower rays of pectoral pale; dorsal and anal yellowish brown, each with a darker brownish marginal band, with pale tip to the rays; outer caudal rays pale, middle rays longest and very dark, making the fin double truncate.

Echeneis remora Linné.

Syst. Nat. ed. 10, 1758, p. 260. Day, Fishes of India, 1876, p. 258.
Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 494.

No. 05940, four specimens, $3\frac{1}{4}$ to $6\frac{1}{4}$ inches long from Surface at Station AA11, Sept. 3, 1899.

No. 05942, M. C. Z. 29466, two specimens, $3\frac{1}{2}$ and $3\frac{3}{4}$ inches long from Society Islands.

No. 05941, four specimens, $3\frac{1}{8}$ to $9\frac{1}{2}$ inches long from Fakarava, Paumotu Islands.

PLEURONECTIDAE.

Platophrys mancus (Broussonet).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 412.
Pleuronectes mancus Broussonet, Ichth. sist. Piscium, 1782, pl. 3, 4.

No. A178, a specimen, $9\frac{1}{4}$ inches long from Arhno, Marshall Islands. Dorsal 99; anal 77; pectoral equals head.

No. A43, M. C. Z. 29720, a specimen $8\frac{3}{4}$ inches long from Fakarava, Paumotu Islands. Dorsal 100; anal 79; pectoral slightly shorter than head.

No. A69, a specimen $7\frac{3}{8}$ inches long from Makemo, Paumotu Islands. Dorsal 100; anal 80; pectoral reaches edge of preopercle.

No. 05945, M. C. Z. 29512, a specimen $1\frac{5}{8}$ inches long from Fakarava, Paumotu Islands.

Platophrys pantherinus (Rüppell).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 512.
Rhombus pantherinus Rüppell, Atlas, 1828, p. 121, pl. 31, fig. 1.
Rhomboidichthys pantherinus Günther, Fische der Südsee, 1909, **8**, p. 342.

No. A132, $9\frac{1}{2}$ inches long from Kambara, Fiji Islands. Three specimens from the following places in Paumotu Islands: Nos. A42, M. C. Z. 29735, 09008, M. C. Z. 29474, 7 and $1\frac{5}{8}$ inches long from Fakarava and 05832, 5 inches long from Makemo.

No. 09012, $3\frac{5}{8}$ inches long from Guam. Nos. 09056 and 09097, $1\frac{1}{2}$ and $3\frac{1}{2}$ inches long from Moen, Truk Group, Caroline Islands. No. 10060, $1\frac{1}{4}$ inches long from Papeete, Tahiti, Society Islands. No. 09002, M. C. Z. 29535, $5\frac{1}{2}$ inches long from Namuka, Tonga Islands.

In No. A42, dorsal 91, anal 69; the pectoral not reaching edge of preopercle and is 1.5 in head; eye equals distance between interorbital rims.

In specimen A132, pectoral does not reach caudal, but is nearly twice as long as head; dorsal 91; anal 67. These specimens of *P. pantherinus* have a much larger eye than *P. mancus* has, the upper eye being 4.33 in head, it about equals the distance between the orbital rims; in *P. mancus* the eye is 5.5 in head and about half the distance between the orbital rims.

SOLEIDAE.

Pardachirus pavoninus (Lacépède).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 413.
Achirus pavoninus Lac. Hist. Nat. Poiss., 1802, **4**, p. 658, 660, 661. Day, Fishes of India, 1877, p. 127, pl. 93, fig. 2.

No. 08937, a specimen $2\frac{5}{8}$ inches long from Tonga Islands.

It is said of this species that only the scales on the head and anterior part of body are ciliated, but in the specimen No. 08937 all the scales on both sides of the body are ciliated.

BALISTIDAE.

Balistes vidua Solander.

Zool. Voy. Sulphur. Ichth., 1845, p. 128, pl. 59, figs. 9, 10. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 409, pl. 61. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 361.

Melichthys vidua Bleeker, Atlas Ichth., 1865, **5**, p. 107, 109, tab. 217, Balist., 3, fig. 2

Nos. A29, $7\frac{7}{8}$ inches and A30, M. C. Z. 29766, $6\frac{3}{8}$ inches long from Tahiti, Society Islands.

Balistes capistratus Shaw.

Gen. Zool., 1804, **5**, p. 417 (after Lacépède). Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 411, fig. 181.

Balistes (Balistapus) frenatus, Bleeker, Atlas Ichth., 1865, **5**, p. 110, 114, tab. 223, Balist. 9, fig. 2.

Nos. A70, $11\frac{1}{2}$ inches and A89, M. C. Z. 29740, $10\frac{1}{2}$ inches long, from Makemo, Paumotu Islands.

Balistes niger Bonnaterre.

Ichthyologie, 1788, p. 19, pl. 85, fig. 352.

Balistes (Balistapus) conspicillum Bleeker, Atlas Ichth., 1865, **5**, p. 111, 116, tab. 221, Balist. 7, fig. 2.

Balistes conspicillum Günther, Cat., 1870, **8**, p. 220.

Balistes niger Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 362.

No. A195, a specimen, 10 inches long from Jaluit, Marshall Islands.

Balistapus aculeatus (Linné).

Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 414, pl. 62. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 362.

Balistes aculeatus Linné, Syst. Nat. ed. 10, 1758, p. 328.

Nos. A199, M. C. Z. 29791, $5\frac{5}{8}$ inches, and 08950, $4\frac{1}{5}$ inches long from Kusaie, Caroline Islands. Nos. 05928 to 05930, four specimens, $4\frac{1}{4}$ to 7 inches long from Rangiroa, Paumotu Islands. No. 08849, two specimens, M. C. Z. 29457, $1\frac{3}{4}$ and $4\frac{3}{4}$ inches long from Funafuti, Ellice Islands.

Balistapus undulatus (Mungo Park).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 363.

Balistes undulatus Mungo Park, Trans. Linn. Soc., 1797, **3**, p. 37.

The collection contains from Marshall Islands, Nos. A187, $9\frac{3}{4}$ inches and

A188, M. C. Z. 29773, 6 inches long, from Jaluit, and A180, M. C. Z. 29767, from Arhno; and 08874, from Suva, Fiji Islands.

OSTRACIIDAE.

Ostracion cornutus Linné.

Syst. Nat. ed. 10, 1758, p. 331. Day, Fishes of India, 1878, p. 697, pl. 176, fig. 4.

Ostracion (Acanthostracion) arcus Bleeker, Atlas Ichth., 1865, **5**, p. 31, 35, tab. 202, Ostrac. 2, fig. 3, and 204, Ostrac. 4, fig. 4.

Lactoria cornuta Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 368.

No. A116, a specimen $10\frac{1}{2}$ inches long from Tongatábu, Tonga Islands.

Ostracion nasus Bloch.

Ausl. Fische, 1787, **1**, p. 121 (118), taf. 138. Günther, Cat., 1870, **8**, p. 263. Day, Fishes of India, 1878, p. 696.

?Ostracion tuberculatum Jordan & Seale, Bull. U. S. Bur. Fish., 1907, **26**, p. 35.

One specimen, No. 09092, one inch long from Moen, Truk Group, Caroline Islands. One specimen M. C. Z. 29600, $\frac{43}{100}$ inches long from Suva, Fiji Islands.

The specimens agree closely with *O. tuberculatum* as described by Jordan & Seale, Günther, and Day (*loc. cit.*).

According to Günther, *O. cubicus*, which he considers synonymous with *O. tuberculatus*, Cat., **8**, p. 260, has the back slightly convex without raised ridge in the median line. According to Day — *loc. cit.*, in *O. nasus* the width of the body is greater than the height, and in *O. cubicus* the width about equals the height. In this character our specimens agree with *O. nasus*.

TETRAODONTIDAE.

Spheroides hypselogeneion (Bleeker).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 368.

Tetraodon hypselogeneion Bleeker, Nat. Tijds. Ned. Ind., 1852, **3**, p. 300. Bleeker, Atlas Ichth., 1865, **5**, p. 60, 61, tab. 218, Gymnod. 9, fig. 5.

No. 08837, three specimens 3 to $3\frac{1}{8}$ inches long from Funafuti, Ellice Islands. M. C. Z. 29429 (1 specimen).

These specimens are badly faded and show no dark bars across the cheek, but they agree very well with Rüppell's plate of *T. honckenji* (Atlas, 1828, pl. 17, fig. 2).

Tetraodon lacrymatus Cuvier.

Quoy & Gaimard, Voy. Uranie, Zool., 1824, p. 204. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 429, fig. 186.

The collection contains Nos. A37, M. C. Z. 29776, a specimen $7\frac{1}{4}$ inches long from Tikei; A55, $5\frac{3}{8}$ inches, Fakarava, and A63, $8\frac{3}{4}$ inches long from Makemo, all in the Paumotu Islands.

Tetraodon manillensis Procé.

Bull. Philom., 1822, p. 130.

Crayracion manillensis Bleeker, Atlas Ichth., 1865, **5**, p. 66, 69, tab. 208, Gymnod. 4, fig. 2.

Tetraodon immaculatus var. *virgatus* Günther, Cat., 1870, **8**, p. 292. Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 370.

Nos. A150, $11\frac{1}{2}$ inches and A139, M. C. Z. 29789, $5\frac{1}{8}$ inches long from Suva, Fiji Islands, and 09061, $\frac{4}{5}$ inches long from Arhno Atoll, Marshall Islands.

Color of back, in A150, dark brown, growing lighter downward, becoming white on a level with lower part of pectoral; about 11 narrow black longitudinal stripes between the dorsal and anal with an occasional incomplete line, the complete lines extending nearly to the caudal, especially those above; there are similar, but lighter lines on the belly, extending from the throat to the region of the anal; the lines on body extending on to head, three or four of them encircling the pectoral fin; outer rays of caudal black. In the smaller example (A139) the dark lines not evident on the belly; the prickles on the smaller one proportionately longer.

Jordan & Seale say: "Apparently Dr. Günther is right in regarding *T. manillensis*, with the back streaked, as the young of *T. immaculatus* in which species the back is plain in life. Specimens before us from Negros in the Philippines show that the black stripe on the back disappears with age. Both Günther and Bleeker record specimens of the striped forms of *T. manillensis*, of 10 to 12 inches in length." Since the black stripes are present as shown by Günther & Bleeker, and by our specimens in individuals of 10 or 12 inches in length, and as the striped form is of such wide distribution, the presence of stripes is not a

character peculiar to the young, and if a constant color character is of any specific value this should be considered a distinct species and not the young of *T. immaculatus*. The disappearing black stripe on Jordan & Seale's Negros specimens may be due to the action of the preservative rather than to age.

Canthigaster solandri (Richardson).

Jordan & Seale, Bull. U. S. Bur. Fish., 1906, **25**, p. 371.
Tetraodon solandri Richardson, Zool. Voy. Sulphur. Ichth., 1845, p. 125, pl. 57, fig. 4–6.

Nos. 05933, a specimen 3 inches long from Bora Bora, Society Islands, and 05823, M. C. Z. 29487, a specimen $2\frac{3}{8}$ inches long from Makemo, Paumotu Islands.

These specimens are badly faded, but they agree very well with a specimen from Samoa identified by Jordan & Seale, and with the descriptions of *C. solandri*.

Canthigaster constellatus, sp. nov.

Plate 7, figure 2.

Type No. 65767 U. S. N. M., 2 inches long; cotype No. 29396, M. C. Z. No. 05922, nine specimens $1\frac{3}{8}$ to 2 inches long from Fakarava, Paumotu Islands. These specimens are immature and faded and therefore difficult of identification. But, so far as the color can be determined, they agree with the figure of *Tetrodon ocellatus* Bennett in Fishes of Ceylon, pl. 21, in having apparently the same sort of subdorsal ocellus and the same sort of lines about the eye and snout and back, especially between the dorsal and caudal; the longitudinal row of blue spots in Bennett's figure is indicated by a similar row of white spots in the present specimens; our specimens show in addition irregular dusky blotches, sometimes coalescing, forming a sort of band, sometimes barely visible, extending from just above the gill opening to caudal; the lower edge of these dark blotches sharply define the white ventral portion of the fish; in one or two of our specimens the largest blotch, which is situated just anterior to a vertical line from the subdorsal ocellus, extends a short distance on the side of the belly as a faint dusky bar and upward toward the back; in several there are faint traces of three blotches between the snout and the pectoral, the first situated some distance back of the angle of the mouth, the second below the

anterior margin of the eye, the third below the posterior margin; in one or two specimens there is also a faint blotch-like band across the back, just back of the highest part of the back or hump.

These additional colors may be characters of the young and can hardly be considered of specific value; the close agreement with Bennett's figure would perhaps justify its identification with that species notwithstanding the remoteness of the two localities; however, Bleeker has described a species under the name of *C. bennetti* which he considers identical with Bennett's *C. ocellatus*. In his Atlas, **5**, Bleeker restores *C. ocellatus* Bennett, and figures it (Tab. 214, Gymnod. Tab. 10, fig. 5), but this figure is apparently of a quite different species from Bennett's *C. ocellatus*.

Inasmuch as Bennett's name, *ocellatus*, is preoccupied by Bloch, our specimens, even should they prove identical with Bennett's, would require a new name.

Head 2.5 in length; eye 4 in head; snout 1.68; interorbital about 8; dorsal 10; anal 9; body covered with fine prickles.

DIODONTIDAE.

Diodon hystrix Linné.

Syst. Nat. ed. 10, 1758, p. 335. Jordan & Evermann, Bull. U. S. Fish. Comm., 1905, **23**, pt. 1, p. 437, fig. 192.

No. A31, a specimen $11\frac{3}{4}$ inches long, from Papeete, Tahiti, Society Islands.

ANTENNARIIDAE.

Antennarius bigibbus (Lacépède).

Bleeker, Atlas Ichth., 1865, **5**, p. 10, 21, pl. 199, fig. 3.
Günther, Fische der Südsee, 1876, **5**, p. 165, taf. 105, fig. B.
Lophius bigibbus Lac., Hist. Nat. Poiss., 1798, **1**, p. 325.

No. 05944, a specimen $2\frac{1}{4}$ inches long from Fakarava, Paumotu Islands.

DISTRIBUTION OF THE SPECIES.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Carcharias melanopterus											+		
Albula vulpes						+							
Chanos chanos											+		
Stolephorus delicatulus			+		+						+		
Harengula kunzei			+				+					+	
sundaica													
commersoni							+	+		+			
Saurida gracilis		+											
Anguilla mauritiana		+									+		
otaheitensis										+			
Muraenichthys macropterus			+										
schultzei						+							
Leiuranus semicinctus			+										
Gymnothorax richardsonii										+			
pictus			+			+					+		
rupelliae											+		
tessellatus											+		
stellatus											+		
Echidna tritor											+		
Enchelynassa canina											+		
Uropterygius pantherinus											+		
marmoratus											+		
concolor											+		
Belone platyura							+						
Hemiramphus dussumierii		+	+		+		+	+			+		
affinis		+	+		+								
far								+					
Zenarchopterus dispar		+					+						
Exocoetus volitans													
Cypsilurus speculiger													
bahiensis			+										
Atherina lacunosa		+	+										
endrachtensis	+	+	+				+				+		
vaigiensis	+	+									+		
nisila			+		+								
Liza caeruleomaculata	+	+					+	+					
Liza melinoptera								+					
Liza trochelii	+	+	+			+	+	+	+	+	+		
vaigiensis	+	+	+			+	+	+			+		

DISTRIBUTION OF THE SPECIES—Continued.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Liza borneensis		+						+					
compressa		+											
crenilabis		+	+								+		
Neomyxus chaptali	+		+			+					+		
Sphyraena obtusata		+					+						
forsteri							+						
Polydactylus kuru												·	
Fistularia petimba		-	+				-	-		-	·		
Corythroichthys conspicillatus			+										
specifer		+											
Microphis brachyurus		+											
Hippocampus guttulatus							+						
Holocentrus spinifer											+		
tiereoides			+							+			
punctatissimus											+		
diadema											+		
sammara					·		·				+		
Scomberoides sanctipetri												+	
tolooparah			+		+	+	+	+			+	+	
Trachurops crumenophthalma											+		
Caranx melampygus			+			+	+	-		+	+		
forsteri			+		+	+							
ignobilis												·	
ferdau											+		
Trachinotus ovatus								+					
baillonii						+							
oblongus												+	
Leiognathus fasciatus							+						
splendens							+						
edentula							+						
Apogon frenatus										+			
orbicularis		+											
savayensis		+											
ceramensis		+	-				·						
vaiulae							·						
exostigma											·		
punctulatus								·					
Mionorus waikiki			-										
Paramia quinquelineata								·		-			
Ambassis urotaenia		+					·						
Kuhlia malo										·			
maculata		:											
proxima							·						
sandvicensis											·		
rupestris		·											

DISTRIBUTION OF THE SPECIES—Continued.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Kuhlia taeniura			+										
Paracanthistius maculatus						+							
Anyperodon leucogrammicus						+							
Cephalopholis argus			+		+	+					+		
urodelus			+										
leopardus			+										
Epinephelus merra			+							+	+		
fuscoguttatus			+			+					+		
caeruleopunctatus			+										
Priacanthus cruentatus										+			
Lutianus kasmira							+						
gibbus			+		+		+			+	+		
marginatus		+	+		+		+			+	+		
johnii		+					+						
monostigma		+			+						+		
marginatoides											+		
Therapon maculatus							+						
jarbua							+	+					
Lethrinus ramak					+								
harak		+					+	+					
mahsenoides								+					
moensii							+						
richardsoni		+						+					
Lethrinella miniata											+		
Monotaxis grandoculis			+										
Xystaema argyreum						+							
acinaces						+		+					
oyena	+	+					+	+					
Upeneus vittatus							+						
sulphureus							+						
Pseudupeneus moana		+											
bifasciatus										+			
barberinus		+						+			+		
barberinoides								+					
Mulloides flavolineatus	+					+		+		+	+		
samoensis	+					+		+			+		
Pomacentrus pavo					+						+		
nigricans		+								+	+		
lividus		+											
Abudefduf sordidus											+		
septemfasciatus					+					+	+		
saxatalis											+		
glaucus											+		
zonatus			+										
antjerius			+										

DISTRIBUTION OF THE SPECIES—Continued.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Abudefduf curacao			+										
sexfasciatus										+	+		
Dascyllus aruanus			+							+	+		
trimaculatus			+				+						
pomacentroides					+								
Chromis caeruleus		+			+						+		
Stethojulis strigiventer		+	+								+		
casturi			+										
bandanensis			+			+							
Halichoeres trimaculatus											+		
Julis pulcherrima							+						
Thalassoma lunare			+										
purpureum											+		
Cheilinus digrammus		+			+								
undulatus		+			+		+				+		
Cymolutes praetextatus								+					
Scarichthys caeruleopunctatus								+					
Scarus brunneus			+				+						
pulchellus											·		
bataviensis			+										
Platax orbicularis										+			
Forcipiger longirostris											+		
Megaprotodon trifascialis											+		
Chaetodon setifer		–			+						+		
ulietensis											+		
lunula			+								+		
kleinii			+										
trifasciatus							+						
Zanclus canescens			+			–							
Teuthis nigricans							·						
elongatus		–											
triostegus			+								+		
guttatus					+?						+		
mata											+		
Ctenochaetus striatus										+			
Zebrasoma rhombeum										+			
veliferum										+			
Acanthurus brevirostris											·		
vlamingi											·		
Siganus fuscescens		–											
punctatus			·								·		
rostratus							·						
Sebastopsis scabra		+								·			
Scorpaenopsis laotalae											·		
Sebastapistes gelactacme							·						

DISTRIBUTION OF THE SPECIES—Continued.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Sebastapistes tristis										+			
Pterois volitans			+										
radiata											+		
antennata											+		
Synanceja verrucosa			+										
Caracanthus maculatus											+		
Amphiprioniehthys unipinna											+		
Ophiocara porocephala		+											
Asteropterix semipunctatus											+		
Eviota zonura											+		
Periophthalmus barbarus		+					+						
Oplopomus oplopomus		+											
Ruppellia echinocephalus								+		+	+		
lacunicola											+		
Zonogobius semidoliatus										+			
Vailima stevensoni										+			
Gobius ornatus		+					+	+					
Mapo fuscus		+						+			+		
Glossogobius biocellatus											+		
Awaous genivittatus		+											
Amblygobius phalaena								+					
" sphinx		+											
Gobiodon histrio											+		
atrangulatus											+		
rivulatus											+		
citrinus		+						+					
Sicyopterus taeniurus										+			
Paragobioides grandoculis			+										
Callionymus cookii											+		
Enneapterygius atriceps		+											
Hypleurochilus vaillanti		+									+		
Alticus periophthalmus											+		
caudolineatus											+		
Salarias lineatus			+										
edentulus											+		
Petroscirtes mitratus		+											
quadrimaculatus			+							+			
Fierasfer parvipinnis										+			
Echeneis naucrates						+					+		
remora										+	+		+
Platophrya maneus			+								+		
pantherinus	+	+					+	+		+	+		
Pardachirus pavoninus								+					
Balistes vidua										+			
capistratus											+		

DISTRIBUTION OF THE SPECIES—Concluded.

	Guam	Caroline Islands	Marshall Islands	Ratak Chain	Gilbert Islands	Ellice Islands	Fiji Islands	Tonga Islands	Cook Islands	Society Islands	Paumotu Islands	Marquesas Islands	Open Pacific
Balistes niger			+										
Balistapus aculeatus		+				+					+		
undulatus			+				+						
Ostracion cornutus								+					
nasus		+					+						
Spheroides hypselogeneion						+							
Tetraodon lachrymatus											+		
manillensis			+				+						
Canthigaster solandri										+	+		
constellatus											+		
Diodon histrix										+			
Antennarius bigibbus											+		

EXPLANATION OF THE PLATES.

PLATE 1.

Trachinotus oblongus Cuvier & Valenciennes. Page 272.

PLATE 2.

Fig. 1. *Trachinotus baillonii* (Lacépède). Page 271.

Fig. 2. *Kuhlia malo* (Cuvier & Valenciennes). Page 280.

PLATE 3.

Fig. 1. *Kuhlia maculatus* (Cuvier & Valenciennes). Page 281.

Fig. 2. *Kuhlia proxima* Kendall & Goldsborough. Page 282.

PLATE 4.

Fig. 1. *Lutianus marginatoides* Kendall & Goldsborough. Page 287.

Fig. 2. *Therapon maculatus* Kendall & Goldsborough. Page 288.

PLATE 5.

Fig. 1. *Dascyllus pomacentroides* Kendall & Goldsborough. Page 298.

Fig. 2. *Forcipiger longirostris* Broussonet. Page 306.

PLATE 6.

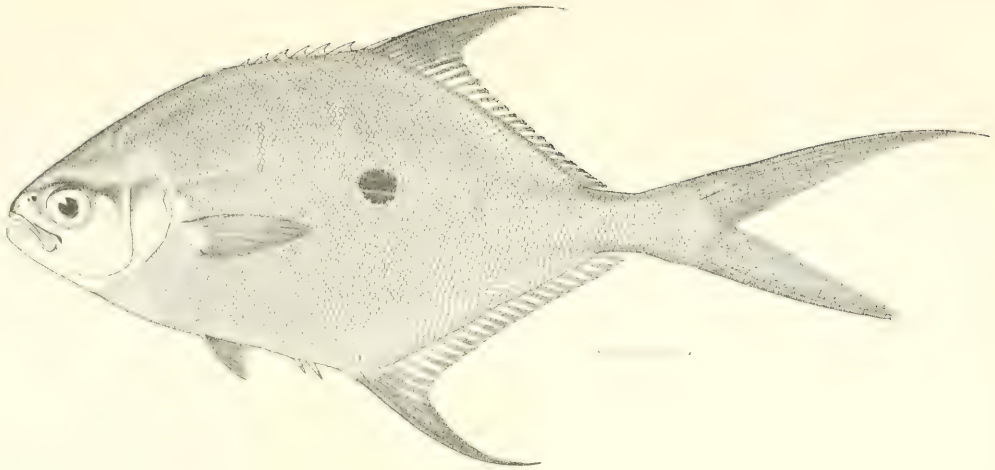
Fig. 1. *Ruppellia lacunicola* Kendall & Goldsborough. Page 318.

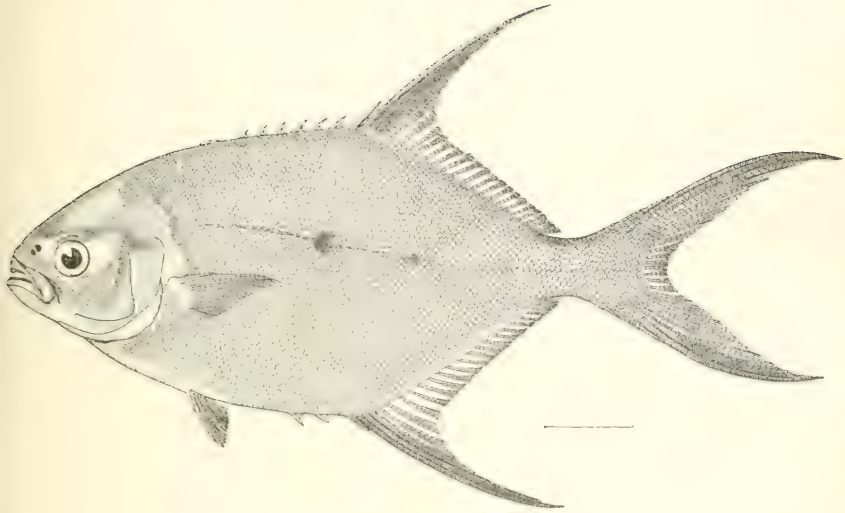
Fig. 2. *Paragobioides grandoculis* Kendall & Goldsborough. Page 324.

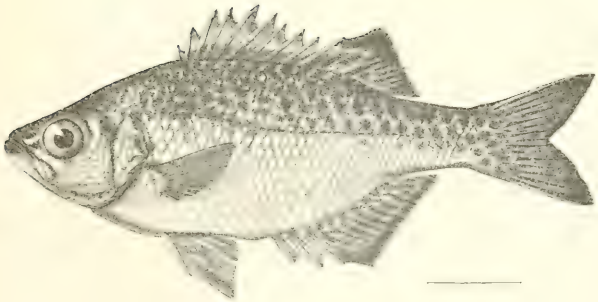
PLATE 7.

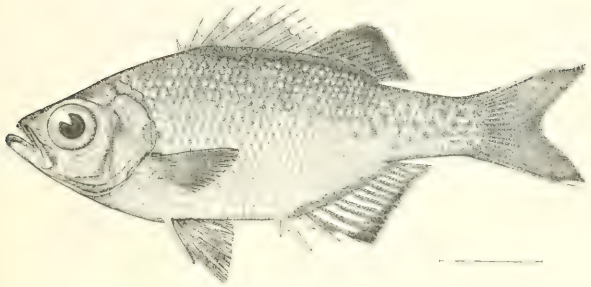
Fig. 1. *Petroscirtes quadrimaculatus* Kendall & Goldsborough. Page 329.

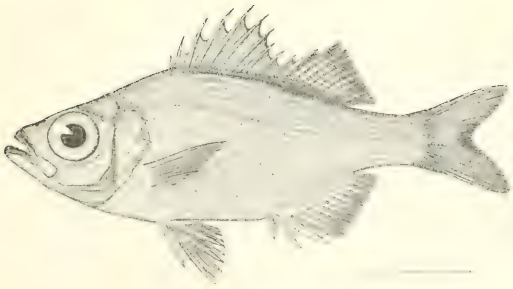
Fig. 2. *Canthigaster constellatus* Kendall & Goldsborough. Page 336.

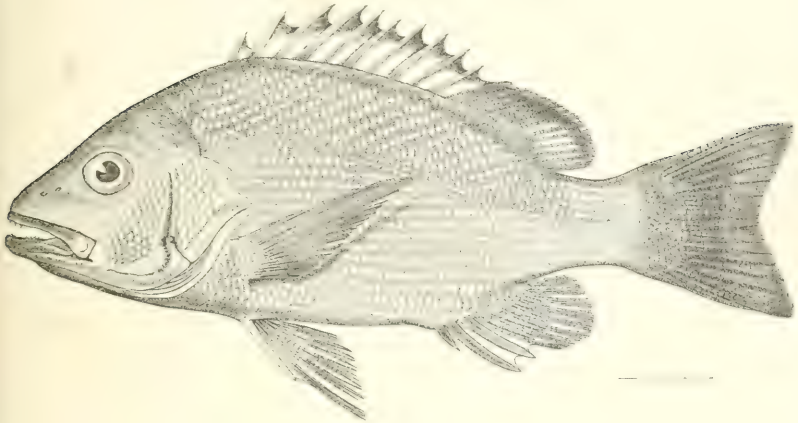


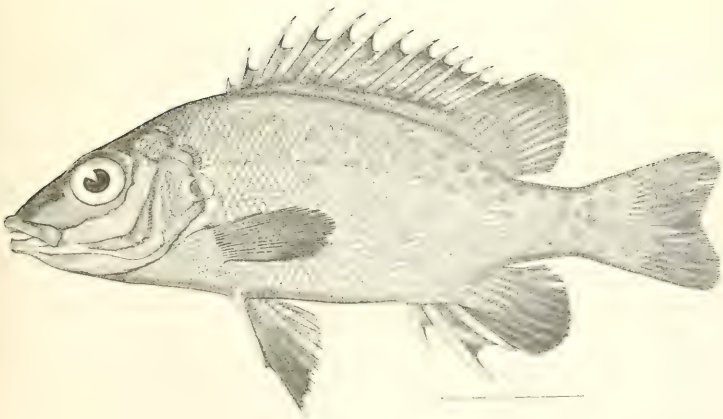












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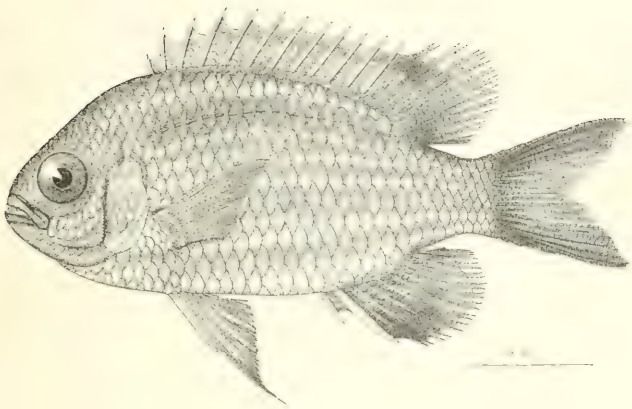

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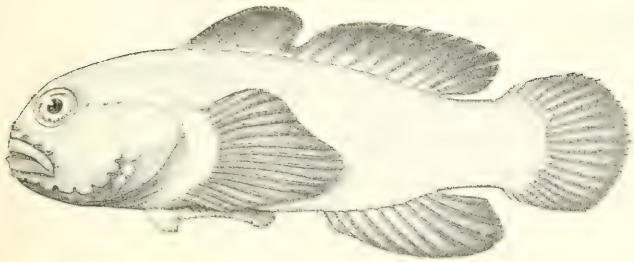

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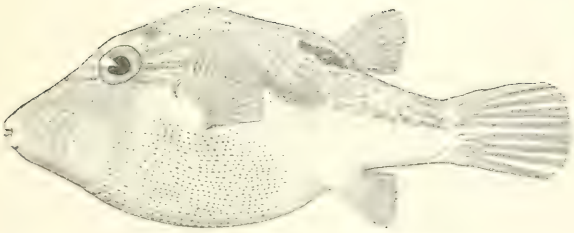

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The following Publications of the Museum contain Reports on the Dredging Operations in charge of Alexander Agassiz, of the U. S. Fish Commission Steamer "Albatross," during 1891, Lieut. Commander Z. L. Tanner, U. S. N., Commanding.

Three Letters from ALEXANDER AGASSIZ to the Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, on the Dredging Operations of the "Albatross" in 1891. Bull. M. C. Z., Vol. XXI. No. 4. June, 1891. 16 pp.

I. A. AGASSIZ. On Calamocrinus Diomedæ, a new Stalked Crinoid from the Galapagos. Mem. M. C. Z., Vol. XVII. No. 2. January, 1892. 95 pp. 32 Plates.

II. A. AGASSIZ. General Sketch of the Expedition of the "Albatross," from February to May, 1891. Bull. M. C. Z., Vol. XXIII. No. 1. February, 1892. 89 pp. 22 Plates.

III. A. GOËS. Neusina Agassizi. Bull. M. C. Z., Vol. XXIII. No. 5. December, 1892. 4 pp. 1 Plate.

IV. H. LUDWIG. Vorläufiger Bericht über die erbeuteten Holothurien. Zeit. Anz.. No. 420. 1893. Bull. M. C. Z., Vol. XXIV. No. 4. June, 1893. 10 pp.

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IX. W. MCM. WOODWORTH. The Planarians. Bull. M. C. Z., Vol. XXV. No. 4. January, 1894. 4 pp. 1 Plate.

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